International Research Journal of Agricultural Science and Soil Science (ISSN: 2251-0044) Vol. 2(1) pp. 008-016 January 2012
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Full Length Research Paper

Comparative study of the efficacy of actyva compound fertilizer (N_{23} P_{10} K_5 3S 2MgO 0.3Zn) on maize cultivation in the coastal savanna and the humid forest ecologies of Ghana

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Accepted 05 December, 2011

Experiments were conducted at Kpong and Kade that, respectively, represent the Coastal Savanna and Humid Forest ecologies of Ghana, to study the response of maize to Actyva fertilizer applications (N_{23} P_{10} K_5 3S 2MgO 0.3Zn) in the two ecologies. The N_{23} P_{10} K_5 3S 2MgO 0.3Zn fertilizer was compared with a no fertilizer control and the commonly used fertilizer, 16-6-16 NPK compound fertilizer basal application and top dressing with ammonium sulphate fertilizer or urea. The fertilizers were applied to the maize crop both in single and split applications. Rainfall in Kpong was high and well distributed in the Major Rainy Season but was low and poorly distributed in the Minor Season. At Kade, rainfalls in both the Major and Minor Seasons were high and well distributed. Organic matter content of soils in the Humid Forest ranges from 4.5 to 6% compared with 2% or less in the Coastal Savanna. The Actyva fertilizer applications in the Coastal Savanna gave significantly higher Plant Height, Total Dry Matter at harvest (TDM) and Grain Yield than the unfertilized control. On the other hand, no differences were observed in the Humid Forest, which had growth and yield values that were greater than observed in the Coastal Savanna. Plant Height at tasseling ranged from 317.1 cm to 335.8 cm at Kade, compared with 110 cm to 170.3 cm at Kpong. Grain Yield in the Major Rainy Season in the Humid Forest zone ranged from 3.71 t ha^{-1} in the control to 4.24 t ha^{-1} for Actyva at 100 kg N ha^{-1} (T3), compared with 1.87 t ha^{-1} to 3.12 t ha^{-1}, respectively, at Kpong. Total Dry Matter was higher under the single fertilizer application than the split application, particularly at the highest levels of fertilizer application (i.e. Actyva at 200 kg N ha^{-1}, T6 and 16-16-16 NPK fertilizer at 100 kg N ha^{-1}, T9). However there was no grain yield difference between the single and split fertilizer applications. The split application of fertilizer thus gave higher Harvest Index than the single application.

Keywords: Coastal savanna ecology, humid forest ecology, actyva fertilizer, major rainy season, minor rainy season, single fertilizer application, split fertilizer application, soil organic matter content.

INTRODUCTION

Maize is a major food staple in Ghana and its scarcity signals food shortage. It is grown in all the agro-ecological zones of the country. In order to achieve high yields, especially on the marginally fertile and infertile lands, fertilizer use is necessary. Studies by Kang et al. (1980), on two soil types, showed that yield of no-tillage maize was less than that of tilled maize with no or low rates of N application, but with adequate N fertilization, yield from no-tillage maize equaled that of tilled maize. It was also shown in the study that regardless of tillage method, there was 38 % or more yield reduction due to

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weeds in the unfertilized plots, with yield of the tilled plots being almost double that in no-tillage plots. The effect of weed competition was partially overcome by fertilization, as yield reductions due to weeds were 19 % or more in the fertilized plots.

In Africa, the method of fallowing land over a period of 7 years or more helped to restore soil fertility. However, pressure on land use as a result of rising populations has resulted in continuous cultivation of land and the 'mining' of soil nutrients. The abandoning of the system of land fallow and crop rotation causes poor balance of nutrients in the soils and depletion of plant nutrients, with estimated negative nutrient balances approaching 20-60 kg N ha^{-1} and 5-15 kg P ha^{-1} annually, for land under continuous cultivation (Smalling, 1993).

Low yields of food crops in Ghana could be attributed partly to declining soil fertility and the inability of farmers to use the required quantities of mineral nutrients. Gilbert et al. (1993) observed that average crop yields, especially cereal yields per unit land area, have fallen in the tropics, partly due to declining soil fertility. In order to have an economically viable and environmentally friendly agriculture, there is need for balanced fertilization through the judicious use of fertilizers (Ernst and Mutert, 1995). IFDC (1998) reported that the annual rate of nutrient depletion from soils of Ghana between 1993 and 1995 in kilograms of $N+P_2O_5+K_2O$ per hectare was 51–100, with the average annual rate of nutrients required to achieve optimum levels of production being greater than 80.

The soils of the Accra Plains, which is within the Coastal Savanna, are largely Vertisols and inherently low in soil fertility, partly due to low organic matter (OM) content (1-2%). The low OM content of the soils could be attributed to the low rainfall (700-1100 mm) that supports lower vegetative growth and decomposition than occurs in the Humid Forest ecology (with annual rainfall of 1500 mm), and also due to annual bush fires, which destroy vegetative cover. Acquaye (1986) observed that soil fertility is closely associated with OM content of the soil, which was determined to be 1-2% (0-15cm depth) in the savanna soils, compared with 4.5-6.0% in the forest soils, where bush fires are less rampant and vegetative material is several fold more than in the savanna belt.

Farmers are aware of soil fertility depletion but they rarely use inorganic fertilizers because of poor availability, high costs and low profits realised from their use (Lameck et al., 2003). Although organic fertilizers are useful for ameliorating physical and chemical properties of the soil, inorganic fertilizers are popular for their ease of application, early crop response, and ease of transportation, as they are less bulky. As indicated by Adediran et al. (2007), many of the manufactured inorganic fertilizers are known to contain no micronutrients vital for crop growth and development; and since the deficiency of these elements have been reported in some tropical soils, there is need to apply nutrient sources that will reduce or eliminate such deficiencies.

The YaraMila Actyva fertilizer formulation (N_{23} P_{10} K_5 3S 2MgO 0.3Zn) has been newly introduced by the YARA fertilizer company to address the lack of certain nutrients, e.g. sulphur and some micro nutrient deficiencies. It has been formulated as a unique fertilizer for basal and top dress applications. Sarfo et al. (1998) noted that for most crops, the best type, rate and time of application are not known and that this constitutes a constraint to the use of fertilizer. They also noted that mineral fertilizers are not used because of their high cost and suggested that lower rates of mineral fertilizers should be included in fertilizer trials because they may be more acceptable financially to producers.

The Actyva fertilizer contains sulphur and micronutrients, which are not present in 16-16-16 NPK fertilizer currently in use. Sulphate of ammonia, as top dressing, provides sulphur but urea does not. Earlier work (unpublished) showed that the use of urea as top dressing, over a long period, brings about sulphur deficiency. South African soils, that are suitable for producing maize, have a considerable lack of sulphur due to low organic matter, low pH and low clay content. Sulfert 8 fertilizer has been formulated to correct the sulphur deficiency. It is rich in sulphur, which it contains in the sulphate form, thus facilitating rapid absorption and prompt correction of sulphur deficiency (Fertilizer Society of South Africa, 2003).

Actyva dissolves quickly and evenly when in contact with the soil in humid conditions or after a night's dew. This means rapid release of nutrients at the correct time to feed the growing crop (www.yara.com). The nitrophosphate production process gives it a unique combination of polyphosphates and orthophosphates. These forms give greater availability of soluble phosphate to crops, over a wide range of soil types (www.yara.com).

MATERIALS AND METHODS

Experiments were conducted within the Coastal Savanna ecology, at Kpong and the Humid Rainforest ecology, at Kade, both in the Eastern Region of Ghana, with the purpose of: (i) Evaluating the efficacy of N_{23} P_{10} K_5 3S 2MgO 0.3Zn fertilizer in the production of maize, in comparison with the current practice (NPK compound fertilizer basal application and top dressing with ammonium sulphate fertilizer or urea) and (ii) Determining the rate of application of the N_{23} P_{10} K_5 3S 2MgO 0.3Zn fertilizer, the mode of application for excellent result (i.e. single application or split application) and (iii) Determining the effect of the micronutrients, 3S 2MgO 0.3Zn, on the growth and yield of maize.

The coastal savanna ecology

Experiments were conducted at the Agricultural Research Centre, Kpong, with soil type mainly Vertisol and clay, silt and sand fractions (at 0-15 cm depth) 43%, 20% and 36%, respectively. The nitrogen, phosphorus and potassium contents of the soil (0-15 cm depth) are low – 0.07%, 11.8 mg kg^{-1} and 27 mg kg^{-1}, respectively. Leaf samples were also taken for nutrient analysis.

Table 1. Monthly Rainfall in 2008, at the Agricultural Research Centre, Kpong

Month	**Rainfall** (mm)
January	0.0
February	9.0
March	87.5
April	107.3
May	158.5
June	210.0
July	119.1
August	36.4
September	76.1
October	119.0
November	17.8
December	41.9
Annual Total	**982.6**

The experimental design was split plot, with four replications. The main plot was mode of fertilizer application, in which fertilizer was applied in two splits (half applied two weeks after planting and the other half at time of tasseling) and fertilizer applied once (at two weeks after planting). The sub-plot treatments were: i) No fertilization – Control, T1, ii) Actyva fertilizer application (N_{23} P_{10} K_5 3S 2MgO 0.3Zn) to supply 50% N requirement (i.e. 50 kg N ha^{-1}), T2, iii) Activa fertilizer application to supply 100% N requirement (i.e. 100 kg N ha^{-1}), T3, iv) Activa fertilizer application to supply 100% N requirement plus supplementary application of triple superphosphate and potassium sulphate fertilizers, to make up for the shortfall of P_2O_5 and K_2O, respectively, T4, v) Actyva fertilizer application to supply 150% N (i.e. 150 kg N ha^{-1}) requirement, T5, vi) Actyva fertilizer application to supply 200% N requirement (i.e. 200 kg N ha^{-1}), T6, vii) Current recommended fertilizer application – basal application of NPK 16:16:16 fertilizer and topdressing with sulphate of ammonia fertilizer, T7 or topdressing with urea fertilizer, T8 and viii) Application of NPK 16:16:16 fertilizer to supply 100% N requirement (i.e. 100 kg N ha^{-1}, T9).

The rainfall pattern at Kpong is bimodal and the annual rainfall in 2008, when the experiment was conducted, was 982.6 mm (Tables 1). Rainfall within the cropping period in the Major Season (May-August) was 524 mm and was well distributed. Rainfall in the Minor Season (September-December) was 254.8 mm and was poorly distributed.

The Major Season experiments were planted on 14th May 2008 and the seeds emerged on 20th May 2008 (6 days after sowing - DAS). The seeding rate was 20 kg ha^{-1}, on a plot size of 6m x 4m. Planting was at 3 seeds per hole and thinned to two plants per hill. Fertilizer was applied on 6th June 2008 (23 DAS). Data was collected on Plant Height at tasseling (61 DAS), Total Dry Matter at harvest and Grain Yield. The Minor Season experiment was planted on 15th September 2008 and data collection was as indicated for the Major Season.

The humid forest ecology

The experiments were conducted at the Agricultural Research Centre, Kade, which also has a bimodal rainfall pattern. The soils were mainly of the Nzima soil series, which are deep and well drained and have clay, silt and sand fractions (at 0-15 cm depth) of 11%, 53% and 36%, respectively. The nitrogen, phosphorus and potassium contents of the soil (0-15 cm depth) were – 0.41%, 13.9 mg kg^{-1}, and 24.6 mg kg^{-1}, respectively.

The annual rainfall of the year, 2008, was 1486.6 mm and rainfall within the growing period in the Major Season (May to August) was 589.6 mm (Table 2). Rainfall in the Minor Season (September-December) was 522.8 mm

The experimental design was randomised complete block, with four replications and plot size 8m x 4m. In the Major Season experiment, the fertilizers were applied in two splits - half applied two weeks after planting and the other half at time of tasseling. The fertilizer treatments were as indicated for the experiments at Kpong. In the Minor Season, however, there were both single application and split application of the fertilizers, within a randomised complete block design as follows:

i) No fertilization – Control, ii) Activa fertilizer application (N_{23} P_{10} K_5 3S 2MgO 0.3Zn) to supply 50 kg N ha^{-1}, applied once, iii) Activa fertilizer application to supply 100 kg N ha^{-1}, applied once, iv) Activa fertilizer application to supply 150 kg N ha^{-1}, applied once,

v) Activa fertilizer application to supply 200 kg N ha^{-1}, applied once, vi) Activa fertilizer application (N_{23} P_{10} K_5

Table 2. Monthly Rainfall in 2008, at the Agricultural Research Centre, Kade

Month	**Rainfall** (mm)
January	0.0
February	109.8
March	86.2
April	177.4
May	171.4
June	132.8
July	209.6
August	75.8
September	46.8
October	197.4
November	160.0
December	118.6
Annual Total	**1485.8**

Table 3. Quantities of Fertilizers/Nutrients Applied

Treatment	**Fertilizer Type and Quantity (kg ha^{-1})**	**Nitrogen Content (kg N ha^{-1})**	**Phosphorus Content (kg P_2O_4 ha^{-1})**	**Potassium Content (kg K_2O ha^{-1})**
T1 (control)	0	0	0	0
T2	ACTIVA (217.4)	50	21.8	10.9
T3	ACTIVA (434.8)	100	43.5	21.7
T4	ACTIVA (434.8) + TSP (35.9) + KCl	100	43.5 + 16.5	22 + 18.3
T5	ACTIVA; 652.2	150	65.2	32.6
T6	ACTIVA; 869.6	200	87	43.5
T7	N:P:K 16:16:16 (375) + Sulphate of ammonia (190.5)	60 + 40	60	60
T8	N:P:K 16:16:16 (375) + Urea (87)	60 + 40	60	60
T9	N:P:K 16:16:16 (625)	100	100 P_2O_4	100 K_2O

3S 2MgO 0.3Zn) to supply 50 kg N ha^{-1}, split applied, vii) Activa fertilizer application to supply 100 kg N ha^{-1}, split applied, viii) Activa fertilizer application to supply 150 kg N ha^{-1}, split applied and ix) Activa fertilizer application to supply 200 kg N ha^{-1}, split applied.

The Major Season experiment was planted on 3rd June 2008. The seed rate was 20 kg ha^{-1}, planted at 3 seeds per hole and thinned to two plants per hill. Crop spacing was 0.90 m x 0.4 m Fertilizer was initially applied on 18th June 2008 and top dressing of sulphate of ammonia and urea on 14th July 2008. Plant Height was determined at the tasseling stage (30th July 2008) and Total Dry Matter at silking stage (6th August 2008). The experiment was harvested on 20th September 2008.

Table 4. Mean Plant Height of Maize at Tasseling Stage, in the Major Season, on the Vertisols of the Accra Plains of Ghana

Fertilizer Application	**Plant Height** (cm)
T1	110.0
T2	152.1
T3	160.7
T4	156.0
T5	151.9
T6	170.3
T7	136.3
T8	150.1
T9	160.4
LSD (p≤5%)	**26.30**

The Minor Season experiment was planted on 17th September 2008. The initial fertilizer application was on 6th October 2008 (19 DAS) and for the split application, the second application was on 28th October 2008 (41 DAS). The experiment was harvested on 20th January 2009 (125 DAS). The data collected included: Plant Height at tasseling, Total Dry Matter at silking and Grain Yield.

RESULTS

Major season production on coastal savanna ecology

Rainfall at Kpong was well distributed during the Major Rainy Season (Table 1) and that positively affected the growth and yield of maize. On average, the Activa fertilizer applications gave significantly higher plant heights than the control. The recommended quantities of Activa and NPK 16-16-16 did not give significantly different results from each other (T3 and T4 compared with T7 and T8) - (Table 4). There has been no difference between the single and split applications of fertilizer (Tfert 1 and 2 – mode of fertilizer application) and there was no interaction between fertilizer treatments and mode of fertilizer application. The addition of P_20_4 and K_20 to augment the phoshorus and potassium deficits in T4 did not bring about any significant difference in Plant Height from that of T3.

All the fertilizer applications gave higher Total Dry Matter at harvest (TDM) than the control (Table 5a). Total Dry Matter in T3 did not differ significantly from that of T4. Doubling the quantity of Activa to supply 200% N (T6) gave TDM that was significantly higher than all treatments except that of the application of 16-16-16 NPK fertilizer to supply the recommended requirement of 100 kg N (T9), which delivered higher quantities of P_20_4 and K_20 than recommended. Also, the application of Activa fertilizer at the recommended N level (T3) gave higher TDM than that for the recommended applications of 16-16-16 NPK plus sulphate of ammonia or urea fertilizers (T7 and T8 respectively). There was interaction between mode of fertilizer application and fertilizer treatment, with TFert 1 giving higher TDM values than TFert 2, particularly at the highest levels of fertilizer application (T6 and T9 - Table 5b).

Treatment differences in grain yield were observed in most levels of fertilizer application. Activa application at 100% N requirement plus supplementary P_2O_5 and K_2O fertilizers (T4) gave higher grain yield than observed in 16-16-16 NPK plus sulphate of ammonia (T7). However, there was no difference between the single or split applications of fertilizer (Tables 5a and 5b).

Harvest Index (HI) differences were not observed between treatments but on average, there was difference between the single and split fertilizer applications (Tables 5a and 5b). The split application of fertilizer gave higher harvest index. Leaf N was higher in the single fertilizer application than the split application, and the higher fertilizer doses had higher leaf N than the lower doses (Table 6).

Minor season production on the coastal savanna ecology

Rainfall during the Minor Season was low and poorly distributed (Table 1). The total during the cropping period (September–December) was 254.8 mm.

In view of the low and poorly distributed rainfall, plant growth and grain yield was poor. In the single application of fertilizer, there was no difference in TDM between treatments (Table 7a). Grain yield differences were observed only at the highest levels of N application (T6

Table 5a. Mean Crop Growth and Yield Parameters of Maize on the Vertisols of the Accra Plains of Ghana

Fertilizer Application	Total Dry Matter at Harvest (t ha^{-1})	Grain Yield (t ha^{-1})	Harvest Index
T1	4.65	1.87	0.44
T2	7.13	2.47	0.36
T3	8.86	3.12	0.41
T4	8.46	3.26	0.43
T5	8.74	3.00	0.39
T6	10.10	3.64	0.38
T7	7.14	2.50	0.39
T8	7.36	2.71	0.39
T9	9.34	3.31	0.38
LSD (p≤5%)	**1.26**	**0.67**	**.ns**

Table 5b. Interaction between Mode of Fertilizer Application and Levels of Fertilizer Application on the Vertisols of the Accra Plains of Ghana

Mode of Fertilizer Application	Levels of Fertilizer Application	Total Dry Matter at Harvest (t ha^{-1})	Grain Yield (t ha^{-1})	Harvest Index
TFert 1	T1	4.88	1.58	0.35
(applied single)	T2	9.25	2.65	0.28
	T3	10.15	2.88	0.35
	T4	10.33	3.40	0.35
	T5	9.88	2.33	0.30
	T6	12.00	3.60	0.30
	T7	8.90	2.60	0.35
	T8	7.90	2.18	0.33
	T9	11.15	3.20	0.30
TFert 2	T1	4.42	2.17	0.53
(applied split)	T2	5.01	2.30	0.45
	T3	7.56	3.37	0.48
	T4	6.59	3.13	0.50
	T5	7.61	3.59	0.48
	T6	8.20	3.68	0.45
	T7	5.38	2.40	0.43
	T8	6.82	3.24	0.45
	T9	7.53	3.41	0.45
LSD (p≤5%)		**3.06**	**.ns**	**0.13**

and T9). In the split application of fertilizer, there were no significant differences in TDM and grain yield (Table 7b).

Major season production in the humid forest ecology

Rainfall was well distributed during the Major Season and that positively affected the growth and yield of maize.

Plant Height at tasseling ranged from 317.1 cm in the control to 335.8 cm in T6. Treatment differences were not significant (Tables 8). Total Dry Matter ranged from 7.50 t ha^{-1}, in the control, to 9.32 t ha^{-1} in Activa fertilizer at 100% N, and 10.47 t ha^{-1} in Activa fertilizer at 100% N plus supplement of P and K shortfall (Table 8). There were no significant differences between treatments.

Grain yield in the Major Season in the Humid Forest ecology ranged from 3.71 t ha^{-1} in the control to 4.24 t ha^{-1} in Activa at 100% N, T3 (Table 8). Grain yield in the

Table 6. Leaf Nitrogen Content in the Single and Split Fertilizer Applications

Fertilizer Application	N – content (%) – Single Application	N – content (%) – Split Application
T1	0.34	0.38
T2	0.40	0.38
T3	0.34	0.37
T4	0.34	0.36
T5	0.37	0.33
T6	0.35	0.35
T7	0.36	0.35
T8	0.34	0.33
T9	0.38	0.30
LSD (p≤5%)	**.ns**	**.ns**

Table 7a. Crop Growth and Yield Parameters of Maize on the Vertisols of the Accra Plains (ARC, Kpong), in the Minor Season– fertilizer in two split applications

Fertilizer Application	Total Dry Matter at Harvest (t ha^{-1})	Grain Yield (t ha^{-1})	Harvest Index
T1	1.13	0.02	0.02
T2	1.22	0.09	0.07
T3	2.11	0.14	0.06
T4	2.09	0.16	0.08
T5	1.38	0.21	0.16
T6	2.25	0.39	0.18
T7	1.87	0.26	0.12
T8	1.48	0.22	0.14
T9	2.54	0.50	0.20
LSD (p≤5%)	**.ns**	**0.28**	**0.11**

Table 7b. Crop Growth and Yield Parameters of Maize on the Vertisols of the Accra Plains (at ARC, Kpong), in the Minor Season – fertilizer in single application

Fertilizer Application	Total Dry Matter at Harvest (t ha^{-1})	Grain Yield (t ha^{-1})	Harvest Index
T1	1.21	0.24	0.04
T2	1.35	0.11	0.07
T3	1.75	0.13	0.08
T4	1.76	0.26	0.12
T5	2.23	0.36	0.14
T6	2.30	0.24	0.08
T7	2.11	0.32	0.15
T8	2.31	0.21	0.08
T9	2.31	0.23	0.09
LSD (p≤5%)	**.ns**	**.ns**	**.ns**

standard fertilizer application of NPK compound fertilizer plus urea top dressing (T8) was 4.37 t ha^{-1}. Grain yields did not differ significantly from each other.

Minor season production in the humid forest ecology

The rainfall in the Minor Season was substantial, al-

Table 8. Crop Growth and Yield Parameters of Maize on the Nzima Soil Series (at ARC, Kade), in the Humid Forest Ecology, in the Major Season – fertilizer in two split applications

Fertilizer Application	Plant height at Tasseling (cm)	Total Dry Matter at Harvest (t ha^{-1})	Grain Yield (t ha^{-1})
T1	322.3	7.50	3.71
T2	334.4	10.20	4.23
T3	317.1	9.32	4.24
T4	328.1	10.47	4.23
T5	319.8	10.13	4.21
T6	322.0	10.88	4.23
T7	335.8	10.43	4.15
T8	332.9	10.17	4.37
T9	330.4	10.86	4.77
LSD (p≤5%)	**.ns**	**.ns**	**.ns**

Table 9. Crop Growth and Yield Parameters of Maize on the Nzima Soil Series at Kade, in the Humid Forest Ecology, in the Minor Season – fertilizer in single and also two split applications

Fertilizer Application	Total Dry Matter at Harvest (t ha^{-1})	Grain Yield (t ha^{-1})
No fertilization (Control)	8.12	2.95
Activa at 50% N – applied once	9.59	3.24
Activa at 100% N – applied once	10.21	3.24
Activa at 150% N – applied once	10.12	3.17
Activa at 200% N – applied once	11.54	3.15
Activa at 50% N – split applied	10.36	2.92
Activa at 100% N – split applied	9.31	3.06
Activa at 150% N – split applied	12.69	3.13
Activa at 200% N – split applied	10.85	3.36
LSD (p≤5%)	**.ns**	**.ns**

though not as heavy and well distributed as obtained in the Major Season.

Total Dry Matter in the Humid Forest ecology ranged from 9.31 t ha^{-1}, in the control, to 10.21 t ha^{-1} in Activa at 100% N, for the single application of fertilizer and 9.31 t ha^{-1}, for the split application (Table 9).

DISCUSSION

The greater growth and yield of maize in the Humid Forest ecology than observed in the Coastal Savanna could be attributed to better water availability in the former. Rainfall in the Humid Forest is high and well distributed while the Coastal Savanna has lower rainfall that is poorly distributed. It is generally observed that without fertilization, maize growth and yield are relatively good when rainfall is high and well distributed and if the soil is well drained.

On the other hand, the response of maize to fertilizer application in the Humid Forest ecology has been poorer than obtained in the Coastal Savanna ecology, and that could be attributed to the high level of OM in the Humid Forest. A long term study established in 1912 in Western Nebraska, as part of a rotation study, showed that grain yield increased with increasing N application rate without manure, but no response to fertilizer application was observed where manure had been applied (Eghball et al., 1995).

In the Coastal Savanna, the Activa fertilizer at 100 kg N ha^{-1} gave higher Total Dry Matter than observed in the recommended application of NPK 16-16-16 plus sulphate of ammonia or urea top dressing (T7 and T8, respect-tively). This could be due to the highly soluble N in the

Activa fertilizer. The Activa fertilizer is presented as a balanced source of nitrogen - a balance of nitrate and ammonium nitrogen, and a part of the nitrogen in nitric form, which is directly absorbed by the plant. YARA Ghana advertises that a well timed application of YaraMila Activa minimises nitrogen losses, compared to other NPK and straight fertilizers (wwww.yara.com).

Activa application at 100% N requirement plus supplementary P_2O_5 and K_2O fertilizers (T4) gave higher grain yield than T7. That could be an indication that the micro nutrients, S, Mg and Zn may have enhanced yields in the Activa fertilizer application. As indicated by the manufacturers (www.yara.com), the polyphosphate component of the product assists crop availability of micronutrients, for example magnesium, in the soil solution.

The single application of fertilizer resulted in greater Dry Matter production and lower harvest index, thus indicating greater efficiency in fertilizer use under split application. In spite of low yields in the Minor Season, the single application of fertilizer gave greater grain yield than the split application. Similarly, there has been greater leaf N with the single fertilizer application than the split application, while the higher doses of fertilizer also gave higher leaf N. In dry climates, YaraMila Actyva's greater solubility helps the nutrients reach the roots where limited soil moisture is available (YARA Ghana, wwww.yara.com).

CONCLUSION

The growth and yield of maize has been observed to be better in the Humid Forest ecology, where rainfall is high and well distributed than in the Coastal Savanna ecology, where rainfall is low and erratic.

In view of the high levels of organic matter in soils in the Humid Forest ecology, the response of maize to fertilizer application in that ecology has not been as good as observed in the Coastal Savanna, which has lower levels of organic matter.

By virtue of its greater solubility in the soil and the inclusion of micronutrients in its formulation, the Actyva fertilizer brought about higher growth and yield of maize, compared with equivalent application of the compound fertilizer in use (16-16-16 NPK fertilizer). There has been greater fertilizer use efficiency when fertilizer was applied in two splits than when applied as single dose.

ACKNOWLEDGEMENT

We are grateful to the YARA fertilizer company for funding the above research. Our gratitude also goes to the Wienco fertilizer company for their initial involvement. The role of the YARA liaison on the project, Mr. Eric Quarshie, is greatly appreciated.

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