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Full Length Research Paper

Effects of Terralyt - Plus® on soil pH, nutrient uptake and dry matter yield of Maize

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Acid soils are common in the tropics and managing them for sustainable cropping usually demands soil amendments. A greenhouse experiment was conducted at the Institute of Agricultural Research and Training, Ibadan, Nigeria to evaluate the effects of a soil amendment substance - organic biostimulator - Terralyt-Plus® on the growth, soil pH, nutrient uptake and dry matter production of maize. The soils used for the study (Entisol, Alfisol) were collected from the coastal and forest zones of Nigeria. The Terralyt-Plus® was applied (0, 20, 40 and 60 ml m^{-2}) with the conventional urea, single super phosphate and muriate of potash fertilizers. These were compared with a no-fertilizer control. The experiment was laid out with completely randomised design (CRD) replicated three times. Maize was grown for six weeks when the shoot and roots were harvested for dry matter yield assessment and determination of selected chemical constitutuents. Complementing inorganic fertilizer application with Terralyt-Plus® significantly improved maize performance on the soils. Shoot dry matter yield increased from 15 - 32% compared with sole inorganic fertilizer treatment. It was 64 -77% over the control. Phosphorus uptake was highest at 40 ml m^{-2} on the soil at Ilora while for soils at Ikenne and Badagry; it was at 20 ml m^{-2}. Application of 20 - 40 ml m^{-2} (200 - 400 l ha-1) gave optimum height and dry matter yield of maize, and improved nutrient uptake of maize plant.

Key words: Corn, nutrients, plant growth, SAR, soil fertility.

INTRODUCTION

Fertilizer use is a major input in crop production. To obtain optimum and sustainable crop yields, it is important to formulate a sound fertilization program that involves the use of an appropriate source, dose and method of application (Sobulo and Aduayi, 1992; Chude, 1995) with reference to crop demand and soil supply. Many combinations of the compound fertilizers are made for applications in various parts of the world. The fertilizers produced in various forms undergo evaluation on different crops grown on a wide range of soils under different ecological conditions. In Nigeria, the use of soil amendments has been constrained by economic cost even when positive effects are established. Nutrients-depleted soils are also less structured and can be improved by using soils with amendment materials. However, these have been of limited values because of economic alternative considerations. The search therefore continues for effective soil amendments.

Terralyt-Plus® is a fertilizer - complementary product in liquid form. It is a very good electrolyte for the soil which increases crop yields. It promotes the transport of elec-trons and re-activates the growth of soil micro-organisms so that plants are supplied with more nutrients. It gives the soil a crumby structure and thereby improves the ventilation of the soil. It is very suitable for use on ex-hausted, over - cropped, sandy loamy clay or acid soils. It is necessary to investigate the effectiveness of the material on various crops, particularly, in the tropics. Akande and Adediran (2004) found application of Terralyt-Plus® to improve growth, nutrient uptake and dry matter yield of okra and tomato. This study was conducted to assess the effectiveness of Terralyt-Plus® in improving the growth, yield and nutrient uptake of maize in an Alfisol and in an Entisol of the tropical forest

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Table 1. Pre cropping soil physical and chemical properties.

Soil properties	Ilora	Ikenne	Badagry
pH	5.9	5.45	5.15
Sand (%)	86	84	92
Silt (%)	8	8	5
Clay (%)	6	8	3
Organic C (%)	0.81	0.78	0.96
Exchangeable bases, (Cmol kg^{-1})			
Ca	2.60	0.75	1.40
Mg	1.89	0.49	0.85
K	0.32	0.17	0.21
Na	0.23	0.27	0.24
H	0.11	0.13	0.15
CEC	4.96	1.81	2.85
Total N (%)	0.08	0.08	0.10
Available P (mg kg^{-1})	7.53	6.16	5.02

zone.

MATERIALS AND METHODS

The greenhouse trial was conducted at the Institute of Agricultural Research and Training, Ibadan, Nigeria (lat.7° 22½'N and long.3° 50½'E). The soils used for the trial were collected from Badagry, Ikenne and Ilora in South Western Nigeria. The soils in these locations, classified as Entisol, Alfisol and Alfisol respectively, were air dried crushed and passed through a 2mm sieve. They were filled into 5l plastic pots perforated at the bottom and covered with filter paper. The pots were placed on plastic saucers. Basal application of N, P and K at 200, 125 and 100 mg kg^{-1} soil was carried out, using urea, single super phosphate and muriate of potash respectively. The secondary elements: Mg and S were added each, at 75 mg kg^{-1} soil. Mn, Zn, Cu, B, and Mo were also added at 25, 10, 5, 0.5 0.5 mg kg^{-1} soil, respectively. The basal fertilizer dose was applied to ensure that the crop plants received adequate macronutrients' supply due to their low concentration in the soil and Terralyt. The fertilizers were thoroughly mixed manually with the soils before planting. Terralyt-Plus® was applied using the following rates: 0 ml m^{-2} without basal nutrients (C) and 0, 20, 40 and 60 ml m^{-2} with basal nutrients. All the treatments were replicated three times, using completely randomised design with maize as the test crop. Maize (Variety: TZESR-W) seeds were planted and grown at 2 plants per stand for six weeks. The variety is early - maturing and streak resistant and was vegetatively matured at 6 weeks. The plants were dried Terralyt-Plus® in the oven at 65°C for 48 h to a constant weight to determine the dry matter yield.

A chemical analysis of the Terralyt-Plus® showed that it had a pH of 12.5 and contained 0.02% N, 0.47% P, 0.02% K, 5.6%Na, 0.21% Ca, 0.25% Zn, 0.62%Cu, 0.57%Co, 0.21% Cd, 0.24% Ni and 0.38% Cr. A pre - cropping analysis of the soil was conducted. The results are presented in Table 1. Plant samples were analysed for N, P, K and Ca, using the standard procedure described by IITA (IITA, 1981). Sodium adsorption ratio (SAR) was computed using the formula:

$$SAR = \left\{ \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}} \right\}$$

in accordance with USDA (1954).

Nutrients uptake was estimated as a product of the concentration of nutrients and the above ground dry matter yield. Data generated were subjected to analysis of variance (ANOVA) procedure. Significantly - different mean values were compared using LSD method at 0.05 level of probability (Gomez and Gomez, 1984).

RESULTS

Terralyt analysis

The analysis of the fertilizer supplement shows that it contains low percentage of basic plant nutrients (N, P and K). The Ca content was about ten times the value of N and K, whereas the P was highest among the major nutrients. The Na value was also very high compared with other elements.

Post - cropping soil pH and nutrients

An analysis of the pre cropping physical and chemical properties of the soils showed that the soils were low in exchangeable cations, total N and available P (Table 1). The soils from Ikenne and Ilora were loamy sand, while that from Badagry was sandy. Soil pH from Ilora (5.9) was higher than that of the soil from Ikenne (5.5) which was even higher than that of the soil from Badagry that had a pH of 5.1 (Table 1). Ikenne soil had the lowest

Table 2. Post-harvest physical and chemical properties of soil.

	Ilora				Ikenne				Badagry			
	Terralyt	rate,	ml/m^2			rate,	ml/m^2			rate,	ml/m^2	
Soil properties	0	20	40	60	0	20	40	60	0	20	40	60
pH	5.3	5.9	5.8	6.2	5.5	5.8	5.9	5.9	5.5	5.6	6.0	5.8
Sand (%)	90	89	89	90	84	85	84	84	88	85	85	85
Silt (%)	6	6	7	6	8	8	9	9	6	9	8	8
Clay (%)	4	5	4	4	8	7	7	7	6	6	7	7
Organic C (%)	0.69	0.83	0.91	0.77	0.78	0.98	1.07	0.90	0.40	0.51	0.51	0.39
Exchangeable bases, (Cmol kg^{-1})												
Ca	1.00	0.90	0.75	0.85	2.25	2.20	2.15	2.30	0.90	0.85	0.65	0.80
Mg	0.69	0.51	0.54	0.30	1.71	1.64	1.42	1.82	0.33	0.23	0.29	0.35
K	0.15	0.18	0.18	0.10	0.17	0.29	0.21	0.29	0.25	0.18	0.17	0.17
Na	0.20	2.80	2.80	2.70	0.28	2.80	2.80	3.30	0.29	2.40	2.50	2.50
CEC	2.22	4.50	4.41	3.95	4.66	6.98	6.78	7.78	1.68	3.78	3.74	3.93
Total N (g kg^{-1})	0.07	0.09	0.09	0.08	0.07	0.08	0.10	0.08	0.03	0.06	0.06	0.04
Avail. P (mg kg^{-1})	2.15	3.44	4.30	2.58	11.20	10.75	11.72	10.86	4.29	5.29	4.69	4.86

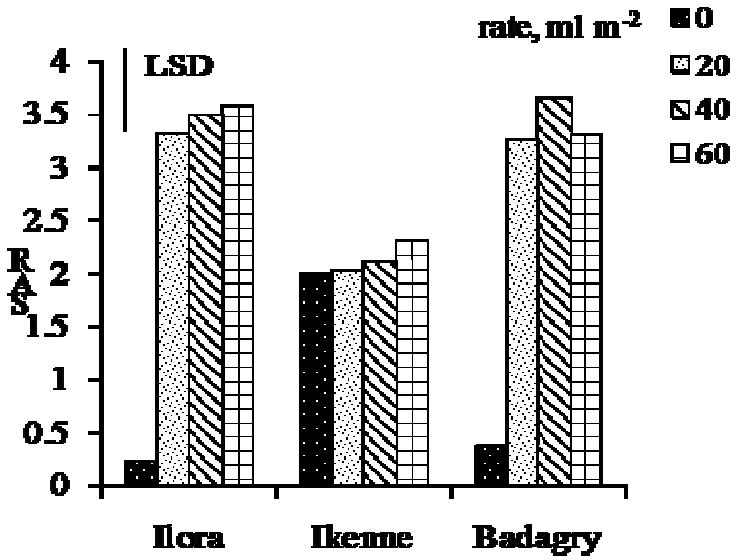

Figure 1. Influence of Terralyt application on soil sodium adsorption ratio (SAR) at post – harvest sampling.

value of exchangeable bases and cation exchange capacity among the three locations. This is a pointer to the need to apply fertilizers to the soils for optimum crop yield.

The post - harvest chemical analysis of the soils showed that the pH of the soils was significantly improved (Table 2). Changes in the soil texture were not consistent. The sodium level in post-harvest soil increased highly for all soils treated with Terralyt Plus®. Residual plant nutrients due to application of the treatments were low. However, the nutrient status of Ikenne soil was higher than in other soils. This was shown in the values of Ca, Mg, CEC, and available P. The results showed that sodium adsorptions ratio (SAR) increased as the level of Terralyt increased and was highly significant only when compared with the control treatment, without Terralyt (Figure 1). On the Alfisol at Ilora, SAR increased from 0.22 at 0 ml m^{-2} to 3.33 at 20 ml m^{-2} and to 3.56 with 60 ml m^{-2} Terralyt. At Badagry (Entisol), the SAR ranged from 0.37 to 3.65 whereas, the

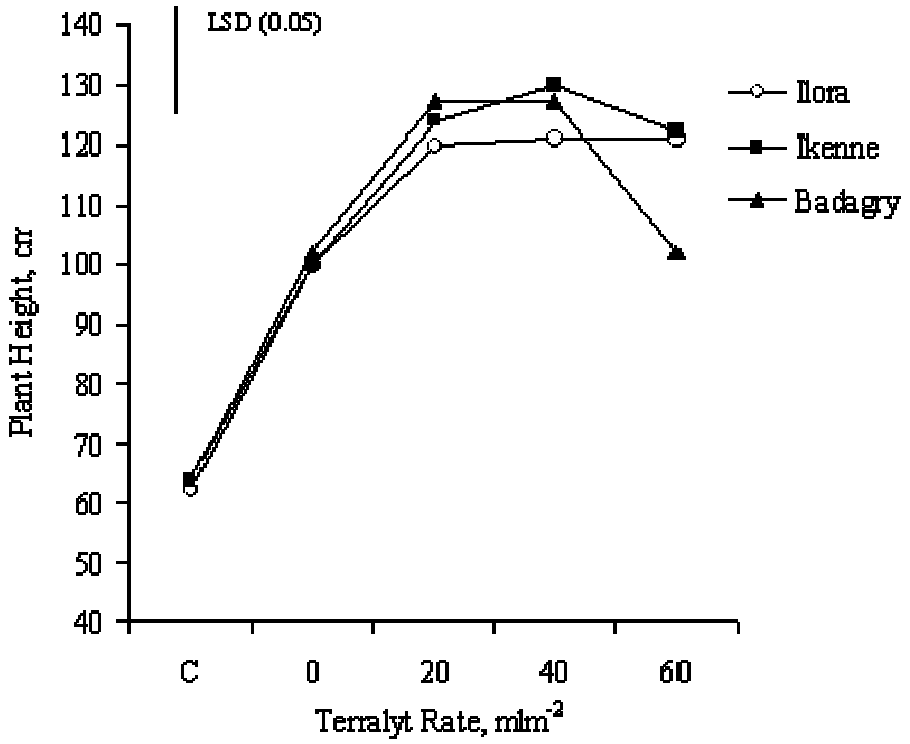

Figure 2. Effect of Terralyt on the height of maize.

SAR of Ikenne soil was generally lower.

Plant height

Application of Terralyt-Plus® gave a sharp increase in maize plant height when applied complemented with the conventional inorganic fertilizer (Figure 2). Addition of 20ml m^{-2} significantly increased plant height by 20 - 24%.

Further increase in Terralyt rate did not show significant difference in height. Application of 60 ml m^{-2} on Badagry and Ikenne soils showed decline in plant height. Plants grown on Ilora soil were generally shorter than those on Ikenne and Badagry soils (Figure 2).

Dry matter yield

Application of Terralyt in combination with inorganic fertilizer significantly increased ($P \leq 0.05$) maize dry matter yield. The shoot dry matter yield increased averagely by 15 - 32% when compared with applying inorganic fertilizer alone and was 64 - 77% over the control treatment, without any of the two nutrient sources (Figure 3). The shoot dry matter was significantly lower ($P \leq 0.05$) on Ilora soil than on other soils.

A similar trend was also observed with roots. However, the root dry matter obtained on Ilora soil was lower (although not significantly) than on other soils. Application of 20 ml m^{-2} gave optimum shoot dry matter while 40 ml m^{-2} was the optimum rate for root dry matter yield (Figure 3).

Plant nutrient uptake

The lowest nutrient uptake was observed from the control treatment. This was followed by the treatment with sole application of inorganic fertilizer (Figure 4). Application of Terralyt at 20 ml m^{-2} gave optimum uptake on the Badagry and Ikenne soils. Phosphorous uptake was highest at 40 ml m^{-2} on the Ilora soil while for Ikenne and Badagry soils. It was at 20 ml m^{-2}. Potassium uptake increased as Terralyt rate increased up to 40 ml m^{-2} on the Ilora and Ikenne soils. However, there was a declining trend on the Badagry soil. On the average, optimum Ca uptake was observed at 20 ml m^{-2}. Heavy metals uptake by maize was comparably fairly low and only excessive or long-term use of the material could possibly cause plant toxicity.

DISCUSSION

Terralyt-Plus® is a synthetic organic product manufactured for soil fertility improvement. An analysis of the product showed that the level of some micronutrients in the material was higher than that of the major elements. This is an indication of the potential use of the material to improve the soil's micro nutrient level. The high value

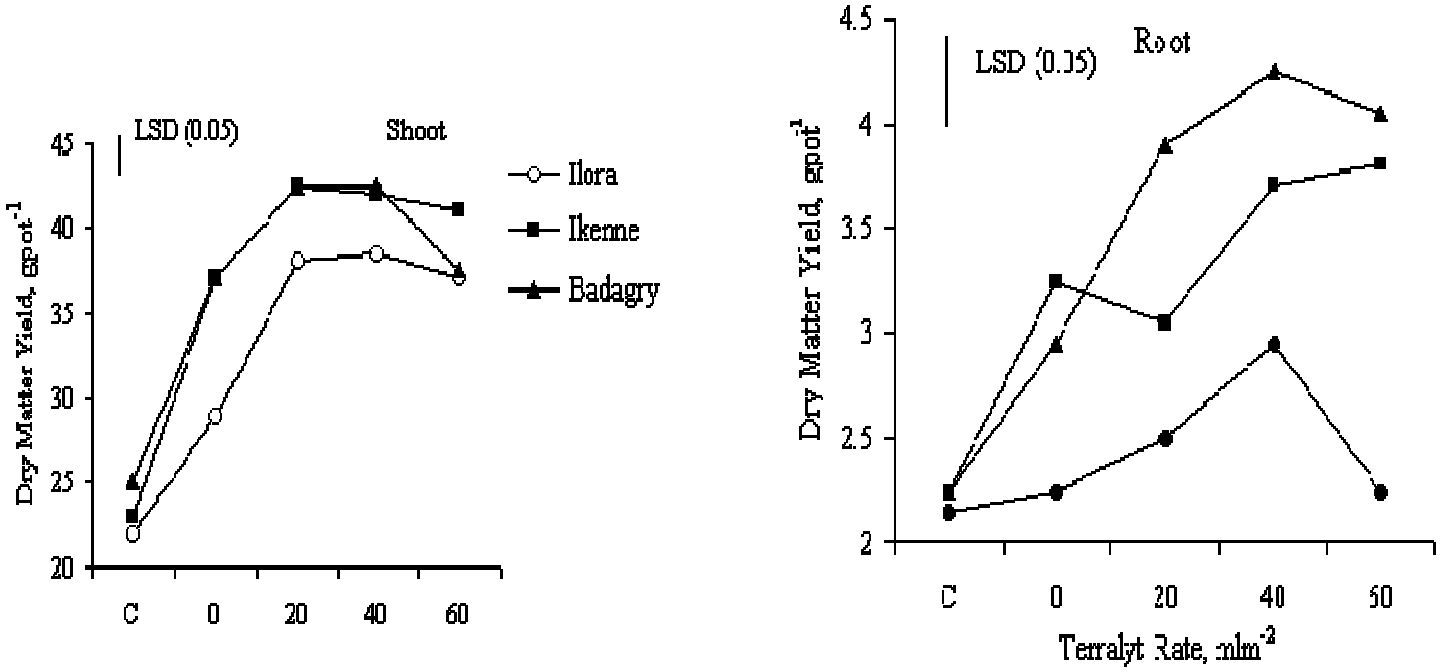

Figure 3. Effect of different rates of Terralyt on dry matter yield of maize.

of Na content might be responsible for the high alkaline nature of the liquid fertilizer. However, the presence of heavy metals such as nickel, chromium, cobalt and cadmium in the material might cause toxicity to plants when used excessively. The low level of the macro nutrients in Terralyt is an indication that sole use of the material might not be adequate for sustaining optimum crop yields. The presence of some micronutrients, such as Zn and Cu is however expected to benefit the crops. The fertilizer contains nickel, chromium, cadmium and cobalt. Application of Terralyt-Plus® with the aim of meeting the nitrogen requirement of maize would result in excessive use and heavy metal toxicity to crop plants.

Application of Terralyt-Plus® was able to reduce soil acidity, while the SAR of the moderately acid soils was greatly affected. This might be due to the alkaline (pH 12.5) nature of the material with high sodium value. The observed low SAR of Ikenne soil was due to the higher availability of Ca and Mg levels and consequently, higher CEC, compared with other soils. This could affect the behaviour of the soil exchange complex and might affect absorption of some other cations and as a result, would cause nutrients imbalance in the soil.

An intensive application of Terralyt-Plus might cause soil salinity and thus affect the behaviour of the soil exchange complex. Also, absorption of some other cations might be affected and consequently cause nutrient imbalance in the soil. Contrary to the observation of Öztürk et al. (2005) on the physical attributes of the soil, a significant change was not observed in this study. This is an indication that the fertilizer complement may have significant effects only on clay soils. Application of an inorganic fertilizer, complemented with Terralyt-Plus® has shown an increase in root and shoot dry matter yield of maize. This is the consequence of the increased intake of nitrogen and phosphorous. An increase in the dry matter production of Tomato from 10.12 g plant^{-1} with sole poultry manure application to 12.28 g plant^{-1} with poultry manure complemented with Terralyt-Plus® has been reported (Akande and Adediran, 2004). Application of Terralyt-Plus® gave a higher effect on nitrogen and phosphorus uptake on soils of Badagry and Ikenne than that of Ilora. Only along-term sole use of the material could cause nutrient imbalance in the soil and consequently reduce crop yields.

Maize plant height was optimum in the three soils with minimal application of Terralyt-Plus® at 20 ml m^{-2}. Increasing application rate gave no further significant increase. The more acidic the soil, the greater the reduction in plant height, with high application of Terralyt-Plus®. This is an indication of over liming with a high dose of Terralyt-Plus® in more acidic soils. An increase in plant height with application of Terralyt-Plus® has been observed with tomato (Ofosu-Anim and Adase, 2008). Similar effects were observed on maize and wheat (Öztürk et al., 2005).

Application of Terralyt-Plus® in this study showed some positive effects on the performance of maize. The positive results obtained from most of the parameters studied indicate that the fertilizer supplement can serve as a supplementary nutrient source and not as an alternative to the conventional fertilizers. A combined use of Terralyt-Plus® with other basic nutrient sources like urea, calcium ammonium nitrate, super phosphate,

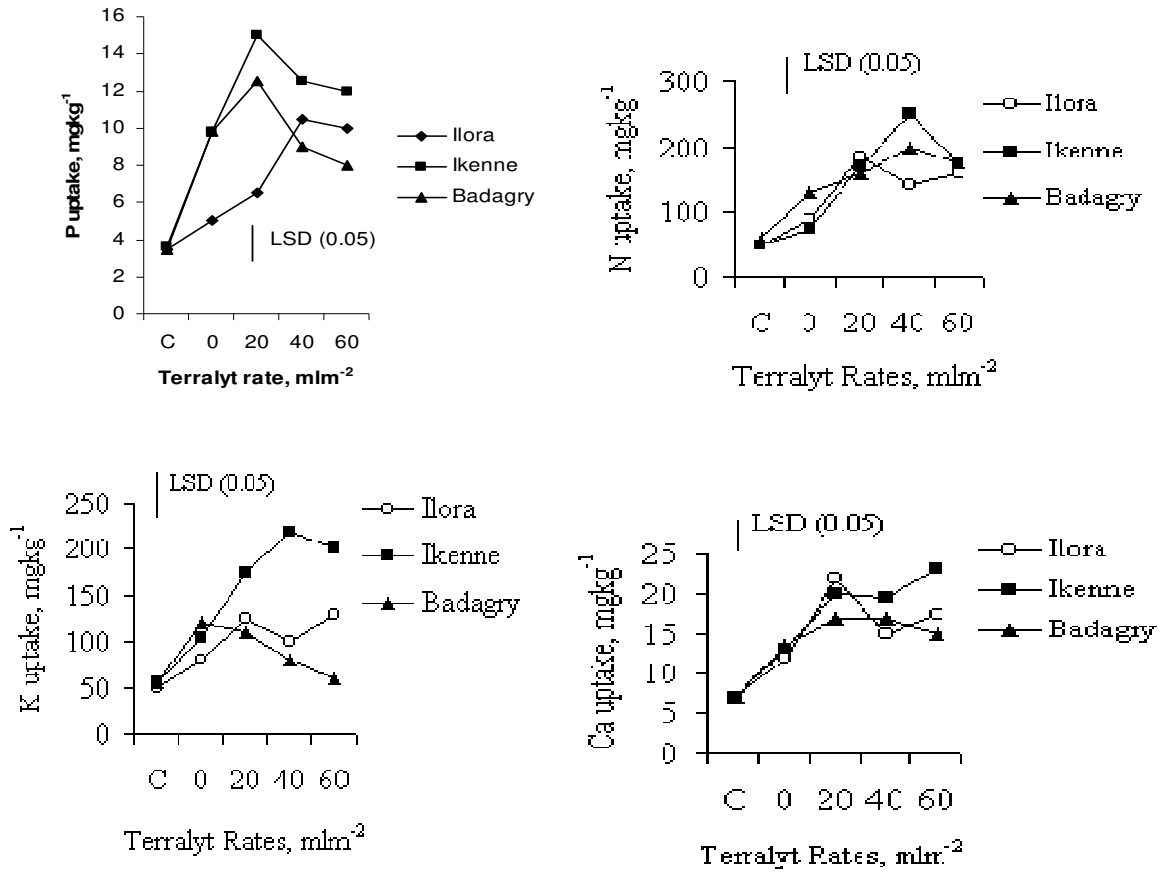

Figure 4. Effect of Terralyt on nutrients uptake of maize.

potassium chloride, compound fertilizers, would improve the efficiency of the materials.

Conclusion

Application of a low dose of Terralyt-Plus® as a compliment to inorganic fertilizers on slightly acid soils reduces the soil acidity and consequently increases nutrient concentrations in the plant tissue. It gives a higher dry matter yield of maize. A minimal dose of 20 – 40 ml m^{-2} (200 - 400 l ha^{-1}) is an optimal rate for maize growth.

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