A LEGACY OF LEADERSHIP: A SPECIAL ISSUE HONOURING THE TENURE OF OUR VICE CHANCELLOR, PROFESSOR ARMAYA'U HAMISU BICHI, *OON, FASN, FFS, FNSAP*

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SEASONAL ASSESSMENT OF SOME ANIONS IN SOIL FROM DUTSIN-MA IRRIGATION FARMLANDS KATSINA STATE, NIGERIA

***Fatima Muhammad**

Department of Biological Sciences, Azman University Kano State. Nigeria

*Corresponding authors' email: fatimuhd99@gmail.com Phone: +2348032932834

ABSTRACT

The most common sources responsible for the high level of anions in the environment are municipal and industrial wastewaters and runoff or leachate from manured or fertilized agricultural lands. This study was conducted to assess the seasonal variations of Nitrite, Nitrate, and Phosphate in soil sampled obtained from Dutsin-Ma irrigation farmlands, A total of ten (10) soil samples were collected from ten irrigation farmlands during dry and wet season. The samples were ground, sieved, and analysed using standard analytical techiniques. Descriptive and inferential statistics were adopted for data interpretations. The concentrations of nitrite, nitrate and phosphate in soil during dry season were 0.24 ± 0.02, 1.06 ± 0.07 and 5.65 ± 0.063 mg/kg respectively while levels during wet season were 1.55 ± 0.03, 2.51 ± 0.04, and 12.3 ± 0.08 mg/kg. There was significant difference in the levels of these anions across the sampling sites ($P < 0.05$).

Keywords: Rice, Nitrite, Nitrate, Concentration, Phosphate

INTRODUCTION

Soluble inorganic anions such as chloride, nitrates, nitrites phosphate, and sulphate, are ions necessary for vital cellular activity in body tissues. They are also known as electrolytes essential for activity needed to support muscle contraction. Plant life cycles are dependent on the availability of essential micro and macro elements for their growth and productivity. Nitrogen, phosphorus, and sulphur make important macronutrients for a large variety of plants and animal (Epstein & Bloom, 2005). Dietary anions have important physiological effects in man such as electrolyte balance and constituent of gastric juice (e.g Cl^-), maintenance of pH (e.g, PO^-), cell signaling, potent vasodilator (Moncada & Higgs, 1993), platelet aggregation inhibitor (Radomski *et al.*, 1991) and bacteriocidal activity (Hogg *et al.*, 1992). The most significant health effect associated with nitrate ingestion is methemoglobinemia in infants. This condition results from the presence of high nitrate level in the blood. Nitrates may act as carcinogens through the formation of N-nitrous compound (Mirvish, *et al.*, 1993). Too much of phosphate can cause health problems, such as kidney damage and osteoporosis. Severe phosphate toxicity can result in hypocalcemia, and in various symptoms resulting from low plasma calcium levels. Moderate phosphate toxicity, occurring over a period of months, can result in the deposit of calcium phosphate crystals in various tissues of the body. Lifetime exposure to phosphate at levels above the maximum acceptable concentration could cause such problems as diuresis and haemorrhaging of the spleen (Adefemi & Awokunmi, 2010). The most common sources responsible for the high level of anions in the environment are municipal and industrial wastewaters and runoff or leachate from manured or fertilized agricultural lands, urban drainage, domestic wastes, soil organic matter, use of nitrogenous or phosphate fertilizers and herbicides, livestock and human excrement and other organic wastes from chemical industries (Johnson & Kross, 1990). Excessive application of nitrogen and other inorganic fertilizers and organic manures to crops lead to accumulation of high levels of nitrate and other anions such as phosphate as well as heavy metals. Also, high amounts of nitrites in soil and water may arise from runoff of nitrogen-containing fertilizers such as potassium nitrite and ammonium nitrite (Akan *et al.*, 2009; Oladeji & Saeed, 2018). The overdose of inorganic anion generates a direct link between the environmental pollution and human health hazard owing to the possibility of entering the food chain (Rouached, *et al.*, 2010; Bryan & Loscalzo, 2011). Farming activities are well pronounced in Katsina State, especially in Dutsin-Ma local government area where they carried out intensive irrigated farming during the dry season due to the high demand for cereals in the region. This work was aimed at assessing some physicochemical properties of some Boreholes and Dams water samples from Ten (10) sampling sites in Dutsin-Ma Local Government Area of Katsina State,

MATERIALS AND METHODS

Study Area

Dutsin-Ma is located at the central part of Katsina state, and lies on Latitude 12^0 26′N and longitude 07˚ 29′ E With estimated area of 552,323 km, and it is bounded in the north by Kurfi, Charanchi and Kankia LGAs. Matazu in the south-east, Safana and Dan-musa from the west (Figure 1).

Sampling

A total of ten (10) samples were randomly collected from ten (Chediya, Garhi, Shantalawa, Tabobi, Katsaba, Badole, Daguda, Makera, Ruwangamji, and Walari) farmlands in Dutsin-Ma local government area of Katsina state during dry and wet seasons. Surface scrapping of the soil were carried out at each point of collection so as to prevent accommodation of extraneous materials along with the samples collected. The samples were collected using plastic spatula from the surface (2 - 20 cm), Soil samples were randomly sampled and bulked together to form a composite sample from each designated point , and immediately packed in pre-cleaned 500 cm^3 polythene containers, labelled and transported to the laboratory for further preparation and analysis. Each Soil sample was air dried under laboratory condition for two weeks, ground, sieved through 2 mm mesh sieve and dried to constant mass in an oven at 105^OC, and kept in a dessicator for further analysis.

The sample sites were coded accordingly as;
Chediya Soil (CSL), Garhi Soil (GSL), Shantalawa Soil (SSL),), Tabobi Soil (TSL), Katsaba Soil (KSL), Badole Soil (BSL), Daguda Soil (DSL), Makera Soil (MSL), Ruwangamji Soil (RSL), and Walari Soil (WSL).

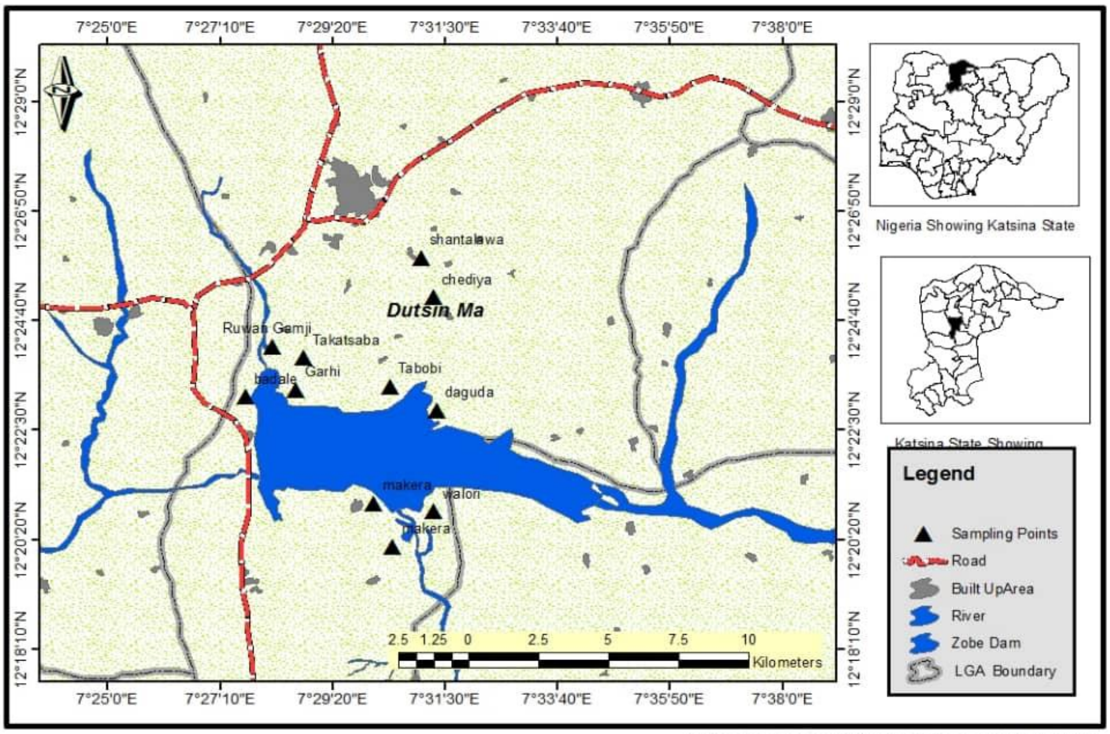

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Figure 1: Map of Sampling Locations

Determination of nitrate and nitrite in Soil Samples
50.00 g of each soil samples were weighed into 250.00 cm^3 conical flasks and shaken with 50cm^3 deionized water (1:1).The shaking was done using a mechanical shaker for 10 minutes. After shaking, the samples were left for 30.00 minutes and filtered using filter paper. The turbid filtrates were centrifuged using 3000cycle/min centrifuge for 5 minutes. The concentration of the nitrate and nitrite in the soil samples filtrates were firstly determined, the readings of nitrate or nitrite were divided by 10 and known amount of 0.02M Ag_2SO_4 were added equivalent to the amount of nitrate or nitrite in the filtrates. 5.00 cm^3aliquots were be then taken into centrifuge test tube and diluted to 10.00 cm^3 with deionized water. The tubes were centrifuged for 10 minutes until the solutions were clear. 5.00 $cm^3$of the clear solutions were taken in glass evaporating dish, placed on water bath, evaporated to dryness and then cooled. 1.00 cm^3 of phenoldisulphonic acid solution was added to individual tubes. Then 10.00 cm^3 of deionized water were added to and transfered into various 100.00 cm^3 volumetric flask and were made alkaline by adding 2.00 $cm^3$of concentrated NH_4OH, diluted to volume of 50 and thoroughly mixed to give a yellow colour and the absorbance were taken at 410 nm using UV/Visible Spectrophotometer for nitrate while for nitrite absorbance were taken at 507 nm. The blank was prepared by following the same method while omitting the filterate used for analysis. (Musa *et al.,* 2009 ; Oladeji & Saeed , 2018).

Determination of Phosphate
About 2.00 g of the soil sample was accurately weighed and placed in a 250.00 cm^3 conical flask, 60.00 cm^3 of HCl and HNO_3 (ratio of 3 to 1) was added and shaken in a mechanical shaker for 30 min. The digestion was done for 6:30 min. This was then filtered using filter paper Whatmann No. 41. About 15.00 cm^3 of the filtered digested sample was taken, 3.00 cm^3 of ammonium molybdate, 2.00 cm^3 of hydrazine sulphate was added and kept in a water bath for 30 min. The blue colour observed was measured spectrophotometrically (Adelowo *et al*. 2016).

Statistical analysis
Results were mean ± of three determinations of each soil from ten (10) irrigated farmland. The results were further subjected to Analysis of variance (ANOVA) using statistical package for social science (SPSS) 21.0 version software.

RESULTS AND DISCUSSION
Concentration of nitrite in Soil
Nitrite level during dry season ranged from 0.17 ± 0.01 - 0.35 ± 0.03 mg/kg and 0.16 ± 0.01 - 2.96 ± 0.02 mg/kg during wet season. RSL had the highest level (0.35 ± 0.03 mg/kg), while SSL (0.17 ± 0.01 mg/kg) recorded the least level during dry season. MSL had the highest value of 2.96 ± 0.02 mg/kg during wet season while TSL had the least level of 0.16 ± 0.01 mg/kg during the same season (Figure 2).

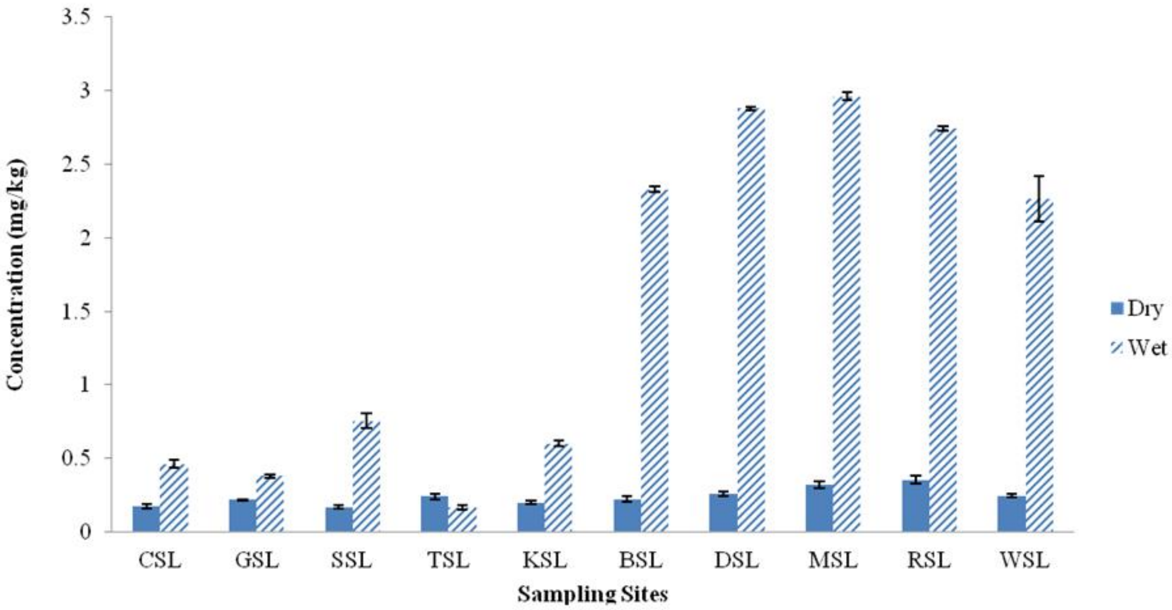

Figure 2: Variations of Nitrite Concentration in Soil across the Sampling Sites

Concentration of nitrate in Soil
Nitrate analysed in soil showed mean levels of 0.41 ± 0.06 - 2.29 ± 0.20 mg/kg during dry season, and 1.78 ± 0.02 - 3.75 ± 0.03 mg/kg during wet season. During dry season, MSL had the highest value of 2.29 ± 0.20 mg/kg while GSL recorded the least value of 0.41 ± 0.06 mg/kg (Fig. 3). During wet season, MSL had the highest concentration of 3.75 ± 0.03 mg/kg, while TSL had the lowest level of 1.78 ± 0.02 mg/kg in the same season (Figure 5).

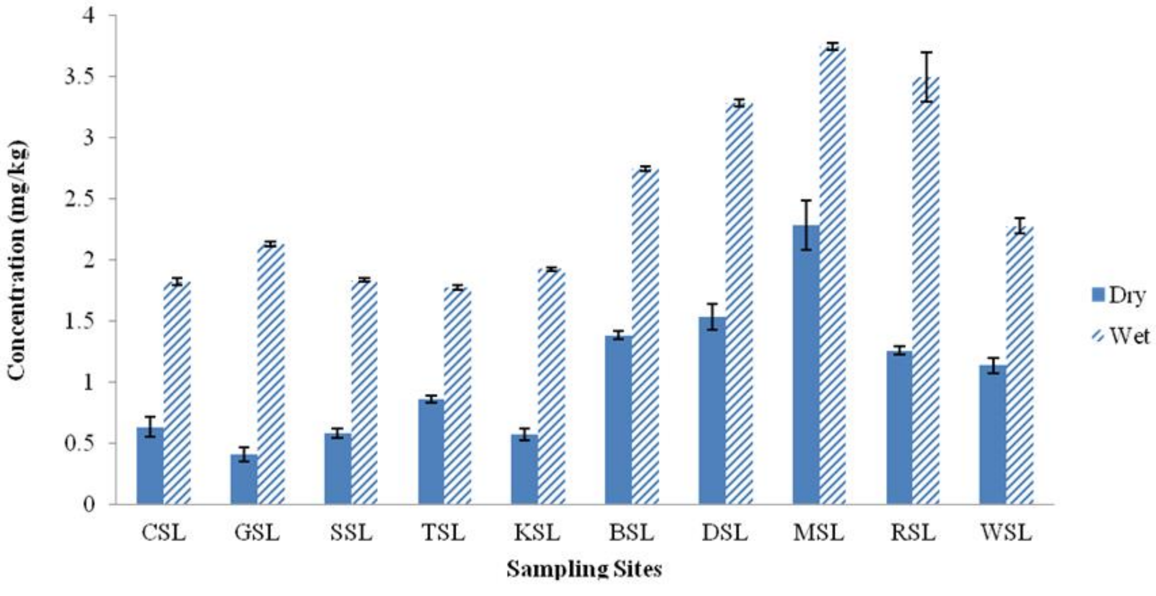

Figure 3: Variations of Nitrate Concentration in Soil across the Sampling Sites

Concentration of phosphate in Soil
The level of Phosphate during dry season is 3.00 ± 0.13 - 8.33 ± 0.01 mg/kg and 7.19 ± 0.02 - 17.40 ± 0.10 mg/kg during wet season. RSL had the highest level of 17.40 ± 0.10 mg/kg and KSL had lowest level of 7.19 ± 0.02 mg/kg during wet season, while WSL and KSL had levels of 3.00 ± 0.13 mg/kg and 8.33 ± 0.01 mg/kg respectively during dry season (Figure 4).

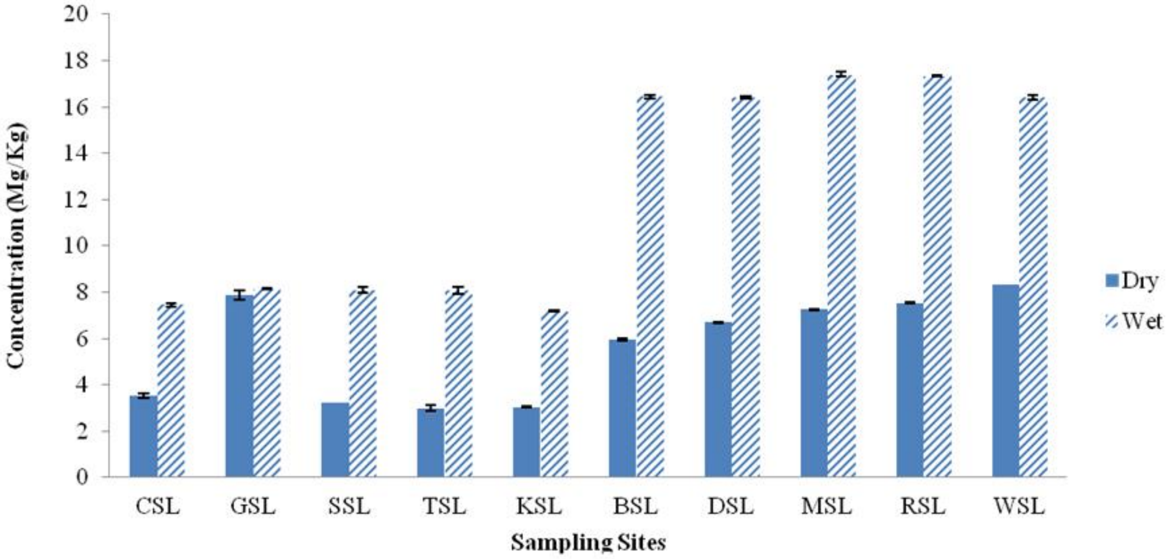

Figure 4: Variation of Phosphate Concentration in Soil across the Sampling Sites.

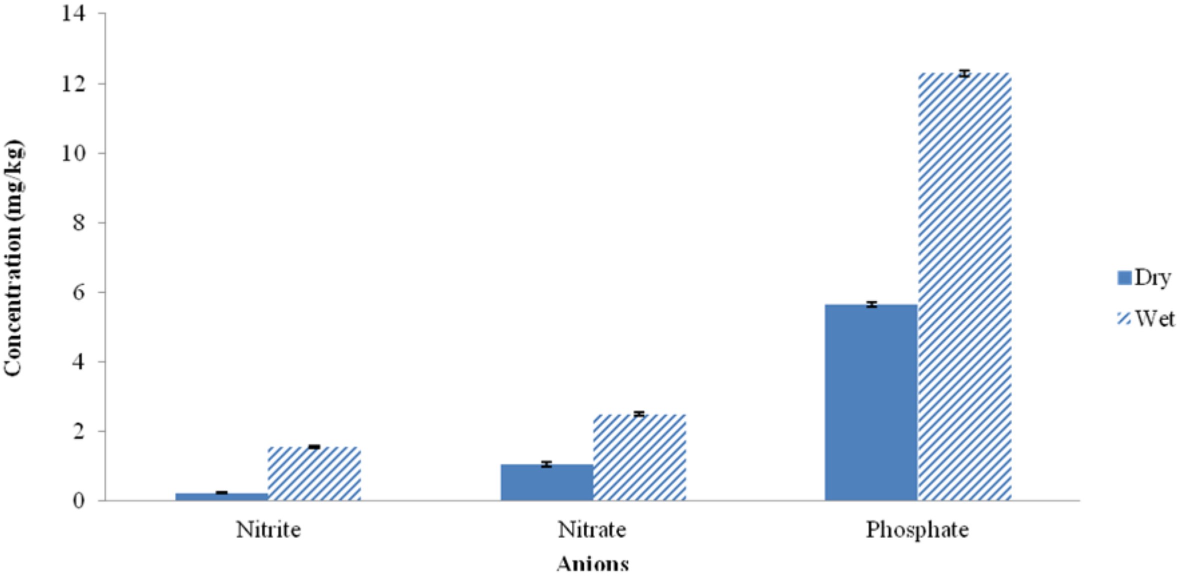

Figure 5: Seasonal Variations of Anions in Soil from Dutsin-Ma Irrigation Farmlands, Katsina State

Discussion

The levels of anions in soil amples from Dutsin-Ma irrigation farmlands for both seasons were presented in Figures 2 – 5. The concentrations of nitrite, nitrate and phosphate in soil during dry season are 0.24 ± 0.02, 1.06 ± 0.07 and 5.65 ± 0.063 mg/kg respectively while levels during wet season are 1.55 ± 0.03, 2.51 ± 0.04, and 12.3 ± 0.08 mg/kg. Seasonal variation of nitrite concentrations shows that, wet season had 1.55 ± 0.03 mg/kg, while dry season had 0.24 ± 0.01 mg/kg (Fig 5). The results of nitrite in this present study partly support the findings of Gutiérrez *et al.* (2016), but disagree with the findings of Tonui (2014) and Uwah *et al.* (2009) who reported nitrite levels of 84.30 - 253.90 mg/kg in soil samples from Maiduguri, Nigeria.

The results of nitrate in soil obtained in this current study disagree with the findings Uwah *et al.* (2009) who reported nitrate level of 198.50 - 311.50 mg/kg in soil samples from Maiduguri, Nigeria. Nitrate levels examined across the seasons showed, 1.06 ± 0.07 mg/kg during dry season and 2.51 ± 0.04 mg/kg during wet season. ANOVA (Appendices V and VI) showed a significant difference in the levels of anions across the sampling locations.

These experimental values of phosphate in soil are lower than results of Gutiérrez *et al*. (2016) but higher than levels reported by Adelowo *et al.,* (2016). Pearson Product Moment Correlation analysis revealed a strong positive relationship in anion levels in soil during dry and raining seasons (Appendices III and IV). Seasonal variation of the levels of anions in soil also revealed high level of anions during the wet season compare to the dry season (Fig 5). The high levels of anions during the wet season can be attributed to more dissolved nitrate and phosphate during the wet season available for assimilation and hence increasing the amount available for absorption. Similar observation was made by Tonui *et al.,* (2014). The high levels of the anions during the wet season could also be due to application of sewage, phosphate enriched fertilizer and other agrochemicals than usual. Human waste could and farming activities are also major contributing factors (McCoy, 2011).

CONCLUSION

The levels of anions in soil samples from Dutsin-Ma irrigation farmlands for both seasons were presented in Figures 2 – 5. The concentrations of nitrite, nitrate and phosphate in soil during dry season were 0.24 ± 0.02, 1.06 ± 0.07 and 5.65 ± 0.063 mg/kg respectively while levels during wet season are 1.55 ± 0.03, 2.51 ± 0.04, and 12.3 ± 0.08 mg/kg. Specific maximum levels for nitrite, nitrate and phosphate in soil are not well- defined. However high levels in soil can be detrimental to plant health and Hence Regular soil testing is of anions concentration in food crops is needed to check for contamination levels. Further study should include other irrigated farmlands in Nigeria.

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APPENDICES

Appendix I: Concentration of Some Anions (mg/kg) in Soil during Dry Season

Locations	Nitrite		Nitrate		Phosphate	
	Mean	Stdev	Mean	Stdev	Mean	Stdev
Chediya (CSL)	0.173	0.015	0.630	0.080	3.533	0.119
Garhi (GSL)	0.217	0.006	0.407	0.059	7.873	0.214
Shantalwa (SSL)	0.167	0.012	0.580	0.040	3.237	0.015
Tabobi (TSL)	0.240	0.020	0.857	0.031	3.000	0.130
Katsaba (KSL)	0.200	0.010	0.573	0.047	3.043	0.021
Badole (BSL)	0.223	0.021	1.383	0.031	5.953	0.031
Daguda (DSL)	0.260	0.017	1.533	0.106	6.690	0.040

Makera (MSL)	0.323	0.023	2.287	0.201	7.260	0.020
Ruwangamji(RSL)	0.353	0.025	1.257	0.031	7.543	0.021
Walari (WSL)	0.243	0.012	1.137	0.064	8.333	0.015
Mean	0.240	0.016	1.064	0.068	5.647	0.063

Appendix II: Concentration of Some Anions (mg/kg) in Soil during Wet Season

Locations	Nitrite		Nitrate		Phosphate	
	Mean	Stdev	Mean	Stdev	Mean	Stdev
Chediya (CSL)	0.463	0.025	1.820	0.027	7.453	0.093
Garhi (GSL)	0.380	0.010	2.130	0.020	8.153	0.040
Shantalwa (SSL)	0.753	0.050	1.833	0.015	8.090	0.123
Tabobi (TSL)	0.163	0.015	1.777	0.021	8.083	0.133
Katsaba (KSL)	0.600	0.020	1.927	0.015	7.193	0.025
Badole (BSL)	2.330	0.020	2.750	0.020	16.440	0.080
Daguda (DSL)	2.880	0.010	3.287	0.032	16.407	0.045
Makera (MSL)	2.963	0.025	3.750	0.030	17.397	0.103
Ruwangamji(RSL)	2.743	0.015	3.497	0.204	17.333	0.023
Walari (WSL)	2.267	0.153	2.280	0.060	16.413	0.121
Mean	1.554	0.034	2.505	0.044	12.296	0.079

Appendix III: Correlation Matrix of Some Anions in Soil Samples during Dry Season

	Nitrite	Nitrate	Phosphate
Nitrite	1		
Nitrate	0.925	1	
Phosphate	0.984	0.951	1

Appendix IV: Table 4: Correlation Matrix of Some Anions in Soil Samples during Wet Season

	Nitrite	Nitrate	Phosphate
Nitrite	1		
Nitrate	0.986	1	
Phosphate	0.978	0.967	1

Appendix V: ANOVA of Some Anions in Soil Samples during Dry Season

Anions	Sampling Sites	Sum of Squares	Df	Mean Square	F	Sig.
Nitrite	Between Groups	0.097	9	0.011	36.869	0.000
	Within Groups	0.006	20	0.000		
	Total	0.103	29			
Nitrate	Between Groups	8.994	9	0.999	138.476	0.000
	Within Groups	0.144	20	0.007		
	Total	9.138	29			
Phosphate	Between Groups	130.846	9	14.538	1785.324	0.000
	Within Groups	0.163	20	0.008		
	Total	131.009	29			

Appendix VI: ANOVA of Some Anions in Soil Samples During Wet Season

Anions	Sampling Sites	Sum of Squares	df	Mean Square	F	Sig.
Nitrite	Between Groups	36.966	9	4.107	1436.136	0.000
	Within Groups	0.057	20	0.003		
	Total	37.023	29			
Nitrate	Between Groups	15.543	9	1.727	347.718	0.000
	Within Groups	0.099	20	0.005		
	Total	15.642	29			
Phosphate	Between Groups	613.505	9	68.167	8754.349	0.000
	Within Groups	0.156	20	0.008		
	Total	613.660	29			