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Analysis of the Levels of Phosphates, Nitrates and Sulfates in the Wheat Growing Area of Ntulele in Narok County, Kenya

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Abstract
This study sampled wheat farms in Ntulele area of Narok county to determine the levels of nitrate, phosphate and sulfate using UV-VIS spectrophotometer and data analyzed using MSTAT-C, SPSS and student t-test. Nitrates were found to be sufficient whereas phosphates and sulfates were found to be deficient in most of the farms sampled. Sulfate had the least CV% of 8.54 followed by nitrates with 14.23% and phosphate had the highest with 21.91% an indication that all the nutrients were applied in similar rates by the farmers of Ntulele. The nutrients before and after planting were significant ($p<0.05$).
Keywords: Nitrate, Sulfate, Phosphate, UV-VIS, Soil, Ntulele

1.0 INTRODUCTION

Soil may be defined as the wethered superficial layer of the earth crust that is made up of decomposed and partly decomposed parent rock material with associated organic matter in various stages of decomposition (Samira *et al*., 2009). Soil characterization in relation to evaluation of fertility status of the soil of an area is an important aspect in context of sustainable agriculture (Singh and Mishira, 2012). The growth and yield of a plant is greatly affected by the levels of some specific mineral nutrients that are absolutely essential for the completion of their life cycle (Mashner, 1995). Application of these nutrients to plants in form of chemical fertilizers is necessary for intensive agriculture inorder to overcome exsiting deficiencies and imbalances. Nitrogen, phosphorus and sulfur are important soil elements that control its fertility and yields of crops (Singh and Mashira, 2012). Nitrogen is most important for crop plants and its availability is closely associated with plant productivity (Zhang *et al*., 2010). This study was carried out to determine the concentration of these three macronutrients in the soil of wheat farms in Ntulele area.

1.1 STUDY AREA

Narok county is located in the southern part of the Riftvalley of Kenya and borders north of Tanzania. Ntulele is found in the eastern part of the county with an altitude of 1827 (5,997 feet) above sea level. The agricultural activities in this area are mainly large scale wheat farming and cattle keeping.

2.0 CHEMICALS, REAGENTS AND MATERIALS

All regents used in this study were all of analar grade and included concentrated nitric acid, sulfuric acid, hydrochloric acid, absolute ethanol, sodium chloride, glycerol, barium chloride, phenol, phenol disulphonic acid, para-nitrophenol indicator, vanadomolybdate

2.1 ANALYSIS OF NITRATES IN THE SOIL SAMPLES

A digestion mixture was prepared by making a mixture of 25g of phenol in 250mL of concentrated sulphuric acid. 1g of soil sample was weighed and placed in a glass conical flask and then 50 mL of the digestion mixture was added and the contents were left to stand for 6hours. 25mL of the digest was placed in crucible and evaporated to dryness on a hotplate and 3mL of phenol disulphonic acid was added and swirled gently and left to stand for 10 minutes. 15mL of distilled water was added and stirred with a glass rod. And on cooling 3 drops of para nitro-phenol indicator was added and ammonia solution added until intense yellow colour was observed. The sample volume was then diluted to 100mL and left to stand for 30 minutes and measurements were done at 420nm using a UV-VIS spectrophotometer.

2.2 ANALYSIS OF SOIL SAMPLES FOR PHOSPHATES

1 gram of the soil sample was weighed and placed in conical flasks, and then 50 mL of the diacid (HCL and HNO_3 in the ratio of 3:1) was added and shaken for 30 minutes in the mechanical shaker, and left to digest for 6 hours. The digest was then filtered using a porous filter paper No. 42. 10 mL of the filtered sample was then

placed in a boiling tube and 3 drops of the nitro-phenol indicator was added. 6N ammonia solution was then added and decolorized using 1N HNO_3 and 5mL of vanadomolybdate and the volume was made up to 50 mL in a volumetric flasks using distilled water. The concentration of the samples was then read after 30 minutes at 400 nm using a UV-VIS.

2.3 ANALYSIS OF SOIL FOR SULFATES

1 gram of the dried soil sample was weighed and placed in plastic bottles and 100mL of distilled water was added and the contents shaken for 1 hour in a mechanical shaker. A volume of 50 mL of the sample was put into 250 volumetric flask and topped up to the mark. The sample was then diluted 50 times and a volume of 5 mL of the conditioning agent (30mL HCL, 100mL ethanol, 75g Nacl and 50mL glycerol) was added followed by 5mL $BaCl_2$ solution and a measurement was read at 420 nm using a UV-VIS.

3.0 RESULTS AND DISCUSSION

Before planting, the sample with the highest concentration of nitrates was sample 12 with a mean concentration of 24.333 ± 0.001 mg/Kg and the lowest concentration was sample 14 with a mean concentration 14.853 ± 0.008 mg/Kg. After planting the highest concentration of nitrates was found in sample 12 with a mean concentration of 45.741 ± 0.004 mg/Kg and the lowest concentration was found in sample 15 with a mean concentration of 21.363 ± 0.008 mg/Kg. The whole study area had a mean concentration of 18.010 ± 2.389 mg/Kg before planting and 28.308 ± 5.922 mg/Kg after planting while a control sample had a concentration of 35.147 ± 0.078 mg/Kg which was higher than all samples from the study area for the two seasons except for sample 12 which had a mean concentration of 45.741 ± 0.004 after planting. This can probably be due to depletion of nitrates as the tilling continues without replenishing of the nitrates over the years, Mesoppirr *et al.,* 2014. The coefficient of variation for nitrate in all the farms for the two seasons was 14.23% indicating that the mean concentrations of nitrate in all farms were not different. This could be attributed to the fact that the farmers applied the nitrates in the some ratio as recommended by the agricultural extension officer in the area. The mean difference in nitrate concentration before and after planting was significant ($P<0.05$).

In this study only one sample before planting were found to be nitrate deficient as values were below the critical level of 15mg/Kg reported by Dennis and John, 2003. After planting all the samples exceeded this critical level due to the addition of fertilizers during planting. The concentration found in this study agrees with the study done by Vanek *et al*., 2003 in the soils of Chavlina. Heckmann, 2003 stated a higher critical level of 20mg/Kg and if this critical level is applied in this study, 87% of the samples before planting were nitrate deficient and all the samples after planting were sufficient.

Before planting, the sample with the highest concentration of phosphates was sample 8 with a mean concentration of 1.086 ± 0.001 mg/Kg and the lowest concentration was sample 2 with a mean concentration 0.387 ± 0.001 mg/Kg. After planting the highest concentration of phosphate was found in sample 10 with a mean concentration of 4.019 ± 0.001 mg/Kg and the lowest concentration was found in sample 1 with a mean concentration of 2.147 ± 0.007 mg/Kg. The whole study area had a mean concentration of 0.730 ± 0.206 mg/Kg before planting and 2.922 ± 0.551 mg/Kg after planting while the control sample had a concentration of 1.594 ± 0.000 mg/Kg which was higher than all samples from the study area before planting and lower than all the samples after planting. This can probably be due to continuous addition of phosphates to the farms over the years leading to accumulation. The coefficient of variation for phosphates in all the farms for the two seasons was 21.91% indicating that the mean concentrations of phosphates in all farms were not very different. This could be attributed to the fact that the farmers applied the phosphates in the some ratio as recommended by the agricultural extension officer in the area. There was lower phosphate concentration before planting than there was after planting. The mean difference in phosphate concentration before and after planting was significant ($P<0.05$)

All the samples found in this study before and after planting are phosphate deficient as values are below the critical level of 5mg/Kg as stated by Wani *et al*., 2011 and Rajaskhekha *et al*., 2010 with only one sample after planting exceeding this critical limit. Courteney *et al.,* 2013 stated a higher critical level of 8mg/Kg and according to this, all the soils samples for both seasons were deficient. In a study done by Anwer and Sattar, 1975 in the soil of Tharparker district found an average concentration of available phosphorous to be 6.85 mg/Kg which is higher than that found in this study for both seasons. The range found in this study after planting agrees with the range found by Tittonel *et al*., 2005 in the soils of western Kenya and those found by Puno, 1991 in Latif Experiment farm, S.A.U. Tandojam, Sindh.

Before planting, the sample with the highest concentration of sulfates was found in sample 1 with a mean concentration of 6.213 ± 0.000 mg/Kg and the lowest concentration was found in sample 7 with a mean concentration 3.021 ± 0.000 mg/Kg. After planting the highest concentration was found in sample 5 with a mean concentration of 8.565 ± 0.000 mg/Kg and the lowest concentration was found in sample 7 with a mean concentration of 4.407 ± 0.007 mg/Kg. The whole study area had a mean concentration of 4.682 ± 0.872 mg/Kg before planting and 6.712 ± 1.030 mg/Kg after planting while a control sample had a concentration of 2.939 ±

0.053 mg/Kg which is lower than all samples from the study area for the two seasons and this can probably be due to continuous addition of sulfates as the tilling continues in an area of study. The coefficient of variation for sulfates in all the farms for the two seasons was 8.54% indicating that the mean concentrations of sulfate in all farms were not different. This could be attributed to the fact that the farms applied the sulfates in the some ratio as recommended by the agricultural extension officer. The mean difference in sulfates concentration before and after planting was significant ($P<0.05$). There was lower sulfate concentration before planting than there was after planting an indication that sulfate was added during planting. All the sampled areas in this study are sulfate deficient because the concentration is below the critical levels as stated by Shill *et al*., 2007; Wani *et al*., 2011 and Rajaskekha *et al*., 2010. 86% soil samples after planting in this study have a moderate concentration with only 6% of the samples before planting having a moderate concentration as stated by Mazvilla, 1998.

Conclusion

The nitrates concentrations varied from 24.333mg/Kg to 14.853 mg/Kg before planting and from 45.741mg/Kg to 21.363 mg/Kg after planting. Phosphates ranged from 1.086 mg/Kg to 0.387mg/Kg before planting and 4.019mg/Kg to 2.147mg/Kg after planting. Sulfates ranged from 3.021 mg/Kg to 6.213mg/Kg before planting and 8.565mg/Kg to 4.407mg/Kg after planting. All the sampled areas were found to be nitrates sufficient but deficient in both sulfates and phosphates. It can clearly be seen that phosphates and sulfates were added during planting but this addition was not enough to make these nutrients sufficient for the crop hence more addition of phosphate and sulfate based fertilizers is still required in the

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Table 1: Table showing concentration of Nitrates, Phosphate and Sulfate

	Nitrate		Phosphate		Sulfate	
Sample	Before	After	Before	After	Before	After
1	16.927±0.001	25.111±0.001	0.685±0.011	2.147±0.007	6.213±0.000	7.195±0.027
2	17.720±0.001	22.683±0.003	0.387±0.001	2.461±0.005	5.544±0.014	7.109±1.088
3	15.757±0.001	28.038±2.823	0.675±0.006	3.019±0.007	3.616±0.010	6.988±0.000
4	15.899±0.009	29.315±2.750	0.911±0.005	2.913±0.013	4.130±0.006	7.776±0.000
5	19.060±0.001	27.096±0.005	0.819±0.005	2.736±0.014	4.042±0.010	8.565±0.000
6	19.868±0.003	23.445±0.006	0.822±0.005	2.473±0.000	5.111±0.001	7.509±0.016
7	18.441±0.001	32.415±0.009	0.585±0.012	3.129±0.006	3.021±0.000	4.407±0.007
8	16.424±0.003	26.561±0.010	1.086±0.001	3.968±0.030	4.411±0.016	6.190±0.003
9	20.025±0.001	34.425±0.005	1.040±0.001	2.949±0.030	5.016±0.006	6.017±0.000
10	17.498±0.001	25.631±0.006	0.401±0.001	4.019±0.001	5.017±0.000	7.323±0.000
11	16.414±0.001	29.177±0.001	0.697±0.004	2.425±0.006	5.551±0.000	6.100±0.000
12	24.333±0.001	45.741±0.004	0.634±0.001	2.518±0.008	4.331±0.000	6.296±0.013
13	19.992±0.003	27.541±0.007	0.879±0.006	2.632±0.022	5.771±0.068	6.773±0.004
14	14.853±0.008	26.082±0.010	0.538±0.003	2.920±0.021	4.259±0.003	5.453±0.016
15	16.936±0.007	21.363±0.008	0.793±0.001	3.518±0.005	4.200±0.000	6.976±0.000

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