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Short Communication

TESTING THE ACCURACY OF SOIL TESTING KIT® TRANSCHEM

***[1]Idris S., [1]Rilwan A., [2]Abubakar S.A., [1]Adamu M., [3]Sadiq Y. and [1]Abubakar F.**

[1]Department of Soil Science, Ahmadu Bello University, Zaria, Nigeria
[2]Indorama Eleme Fertilizer and Chemicals Limited, Port Harcourt, Nigeria
[3]Department of Agricultural & Bio-environmental Engineering, Federal Polytechnic, Bauchi, Nigeria

*Corresponding author's email: sanidris2000@gmail.com; saniidris@abu.edu.ng

ABSTRACT

Soil testing is key to soil fertility management as it serves as a fertilizer application guide to farmers, scientists and consultants. It gives information on soil nutrient status and its supplying capacity. Laboratory (LB) procedures have been the most reliable approach for soil nutrients analyses. However, it is costly and non-point. Thus, the use of in–situ testing kit emerges and becomes prominent. Notwithstanding, applicability of soil testing kit must be validated by laboratory test. This work aimed to examine the reliability/suitability of Soil Testing Kit® Transchem (SK) in determining selected soil nutrients in Sahel Savannah, Nigeria. Twenty-five replicate soil samples were collected from 12°47'86''-12°20'96''N and 4°38'37''-4°188'02''E, Kebbi State Nigeria and used to test soil pH, N, P, K and soil organic carbon (SOC) by SK and LB. The SK uses colour chart and comparator for rating nutrients status qualitatively into; low, medium and high and up to very high for P. The LB results were transformed to qualitative data by corresponding the values with soil rating standard into low, medium and high. To perform statistics, weighting was done by assigning weight load to each category; low = 1, medium = 2 and high = 3. The two methods were compared using t-test, regression and descriptive analyses. Results showed non-significant difference between the two methods for soil contents of N, P and K. However, SK poorly estimated soil pH and SOC. Correlation and regression coefficients ($r = 0.915$ and $R^2 = 0.838$, respectively) indicated reliability of the SK. It is concluded that SK can be reliably used for N, P, and K but not soil pH and SOC estimation for soils in Sahel savannah of Nigeria.

Key words: laboratory method, soil nutrients, validation, Sahel Savannah

INTRODUCTION

Soil analyses is critical in fertility management and site specific fertilizer use for sustainable crop performance and soil productivity (Bassey *et al.,* 2009; Faber *et al.,* 2007). It provides a fertilizer recommendation guide to field farmers, practitioners of home gardening, agricultural extensionists, agro-allied companies, researchers and consultants. Soil test provides information on the ability of soil to retain and supply required nutrients to crops (Avanish *et al.,* 2015). The use of laboratory testing (LB) procedure has been the most reliable way of analysing soil nutrients. Howbeit, it is time cumbersome, costly, energy demanding, non-point and requires high man power. Thus, in-situ test kits emerged and have been gaining wide acceptability. Soil testing kits (SK) were reported to be ecosystem friendly, inexpensive, highly efficient and allow for instantaneous measurement (TARPL, 2017). Development of first soil test kit was credited to Herbert and Ester Atkinson from Sudbury Laboratory in Mass, United State (Fenney, 2019). Soil kits are developed based on bulk soil data from specific climatic and location, hence, calibration and validation becomes necessary (John, 2013). Objectively, applicability of SK must be based on its performance validated by LB test from representative soil under typical field condition of the region concerned (John, 2013). As such, proliferation of SK and its usage begs for validation test in order to ascertain its suitability, reliability and accuracy to specific environment. Faber *et al*. (2007) compared performance of five colorimetric SK commonly available in perfect market with standard laboratory methods based on four key soil fertility parameters; soil pH, nitrate–nitrogen (NO_3), phosphorus (P_2O_5) and K_2O. Result for the accuracy of each kit in percentage revealed that; LaMotte Soil Test Kit > Rapitest > QuickSoiltest > Nitty-Gritty > Soil Kit obtaining 94%, 92%, 64%, 36%, and 33%, respectively (Faber *et al.,* 2007). Also, efficiencies of the test kits varied widely across the individual parameter. The variation was connected to the differences in extractants used (Faber *et al.,* 2007). The result further underscored the need to carryout efficiency and validity assessment on SKs on a wider scale. Ogunlade *et al.* (2019) compared soil pH results of LaMotte, Rapitest, and Hanna soil test kits with results obtained by conventional laboratory method in Cocoa plantation at Akwa Ibom and concluded that only Rapitest varied significantly with the conventional method as it could not test pH below 5.

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This research compared conventional laboratory method with the most commonly used soil testing kit in Nigeria, particularly by Indorama company for the purposes of soil fertility management and fertilizer recommendation. Specifically, the objective of this research was to examine the reliability of Soil Testing Kit® Transchem in determining the most limiting soil nutrients (N, P and K), pH and SOC for soils in Sahel Savannah, Nigeria.

MATERIALS AND METHODS

A total of 25 composite soil samples were randomly collected at 0-15 cm from five selected farmlands in Argungun, Kebbi Sahelian Savannah zone of Nigeria. The farms are being cultivated to cereal/legume intercropping. The research location covers 12° 47′ 86″ to 12° 20′ 96″ N and 4° 38′ 37″ to 4° 18′ 80″ E. Locus Map 4 software was used to take the perimeter of the area which was later imported into GIS environment using ArcGIS version 10.3 for gridding at 30 meters interval. Avenza Map offline was used to navigate to 25 randomly chosen grids (sampling point) for each farmland. Five samples were bulked together to form a single composite sample giving a total of five per farmland. The samples were air-dried, gently beaten with porcelain pestle and mortar and sieved through 2 mm stainless steel sieve. The prepared samples were subjected to standard conventional laboratory (LB) and Soil Testing Kit® Transchem (SK) procedures for comparison.

Based on the kit's manual, specified drops of alpha-numerically labelled reagents were added into samples which lead to colour change for inference. The final colour observed after adding the last reagent was then compared or coincided with a colour chart to arrive at the ratings. As provided in the SK® Transchem manual, (FAO–TCP/SRL/3606) two, three, five, four, and two reagents were used for pH, Nitrogen (N), Phosphorus (P), Potassium (K) and soil organic carbon (SOC) determination, respectively. The same samples were subjected to laboratory tests to serve as a benchmark to the SK results. Soil pH was measured by glass electrode meter in 1:2.5 soil-water ratio (Anderson and Ingram, 1993), total N was determined by micro-Kjeldahl digestion (Bremmer and Mulvaney, 1982), available P by Bray-1 method (Bray and Kurtz, 1945), exchangeable K by flame photometer (Black, 1965), and SOC by Walkley-Black wet oxidation method (Nelson and Sommers, 1982), all in the analytical laboratory of the Department of Soil Science, Ahmadu Bello University, Zaria, Nigeria.

Data Processing

The soil kit uses colour chart to rate the status of the parameters except for K in which comparator is used. Both allow for qualitative rating namely low, medium and high and up to very high for P. The laboratory test results which were quantitative in nature were qualitatively rated as low, medium and high using the soil rating standards of Enwezor *et al.* (1990), Esu (1991) and Soil Survey Manual (1993). Since the two standard ratings don't have very high category as obtained in the soil kit rating, the very high was lumped into high. In order to carryout statistical analysis, weighting was done by assigning weight load to each category as follows: low = 1, medium = 2 and high = 3, while for pH both the laboratory and soil kit methods gave numerical values, hence the raw data was used. IBM SPSS version 20 statistical tool was used to compare the two methods using T- test, descriptive and regression analyses as suggested by (Efren, 2001).

RESULTS AND DISCUSSION

Table 1 and 2 show the percentages of each of all rating categories of the tested parameters obtained by the soil testing kit (SK) and conventional laboratory (LB) methods. For N, the low rating status for SK was 75.0% while LB had 63.0% (diff. 12%); for medium rating, SK had 25.0% while LB had 37.0% (diff. –12%) and for high rating, SK had 0.00% while LB had 0.00% (diff. 0.00%). The P result indicated that SK and LB, had 62.5 and 52.5% of low rating (diff. 10.0%), 7.00 and 0.00% of medium rating (diff. 7.00%) and 30.5 and 45.5% of high rating status (diff. –15.0%), respectively. The SK and LB result for the various K ratings were as follows: low: 0.00 and 7.50% (–7.5%); medium: 37.5 and 37.5% (diff. 0.00%); high 62.50 and 55.00% (diff. 7.5%) respectively. For SOC, the low rating was 12.5% in SK while LB had 17.5% (diff. –5.0%); for medium rating, SK obtained 62.5% while LB had 65.0% (diff. 0.5%) and for high rating status SK had 25.00% and LB had 17.50% (diff. 7.5%). Results for pH revealed that, slightly acidic rating status obtained by SK and LB were 25.00 and 0.00% (diff. –25.0%); for neutral rating status, SK had 37.5% while LB got 87.5% (diff. –50.0%); for slightly alkaline rating, SK obtained 25.0% while LB had 12.5% (diff. 12.5%); for medium alkaline pH rating,

Table 1: Ratings and distribution of some parameters in percentages comparing soil test kit and laboratory results

Method/Rating		Parameters			
		N	P	K	SOC
Soil kit	Low (%)	75.0	62.5	0.00	2.50
	Medium (%)	25.0	25.0	37.5	62.5
	High (%)	0.00	12.5	62.5	35.0
Laboratory	Low (%)	63.0	37.5	7.50	17.5
	Medium (%)	37.0	0.00	37.5	65.0
	High (%)	0.00	62.5	55.0	17.5

SOC - soil organic carbon

Table 2: Ratings and distribution of soil pH in percentage comparing soil test kit and laboratory results

pH ratings (%)	Soil kit	Laboratory
Extremely acidic	0.00	0.00
Very strongly acidic	0.00	0.00
Strongly acidic	0.00	0.00
Medium acidic	0.00	0.00
Slightly acidic	25.0	0.00
Neutral	37.5	87.5
Slightly alkaline	25.0	12.5
Medium alkaline	12.5	0.00
Strongly Alkaline	0.00	0.00
Very strongly alkaline	0.00	0.00

SK had 12.5 while LB got 0.00% (diff. –12.5%). All the remaining ratings (extremely acidic, very strongly acidic, strongly acidic, strongly alkaline and very strongly alkaline) were 0.00 and 0.00% for both SK and LB, respectively. This wide difference between the SK and LB pH results may be connected to the inefficiency of the soil kit reagents for pH determination in bringing about total extraction of H^+ and Al^{3+} from the soil micelles, thereby leading to poor estimation of soil pH. Wrongly determined soil pH may lead to poor interpretation of soil acidity status and subsequently ill-recommendation of management practice.

Table 3 presents t-test output comparing mean values of all the determined chemical properties obtained through Soil test kit (SK) and the conventional laboratory method (LB). From the table, out of the five variables determined only results of SOC and pH showed significant difference between the SK and LB. This finding corroborates the result obtained by Ogunlade *et al.* (2019) who reported poor pH estimation by Rapitest soil kit. It is also in harmony with IFDC (2020) that KASETSART, SOLID DOC, and HACH SW-1 soil kits recorded higher accuracy in N, P and K determination especially in near neutral pH. Regression and correlation results indicated a good fitting and strong positive correlation (R^2 = 0.838 and r = 0.915, respectively). This inferred that, the general performance of Soil Testing Kit® Transchem is reliable and good enough for testing N, P, K, for soils of Sahel Savannah zone, Nigeria.

Table 3: T-test of selected plant essential nutrients comparing soil test kit and laboratory results

Method	Parameter	Mean value	Std. error of mean	p-value
Soil testing kit	N	1.25	0.464	0.619
Lab. method		1.38		
Soil testing kit	P	1.90	0.267	0.122
Lab. method		2.25		
Soil testing kit	K	2.63	0.183	0.445
Lab. method		2.38		
Soil testing kit	SOC	2.13	0.295	0.033
Lab. method		1.5		
Soil testing kit	pH	7.13	0.55	0.043
Lab. method		6.55		

Table 4: Regression of soil testing kit on lab. results

Model	Model	R^2	Adjusted R^2	Std. error of the est.
1	0.915ª	0.838	0.834	0.026

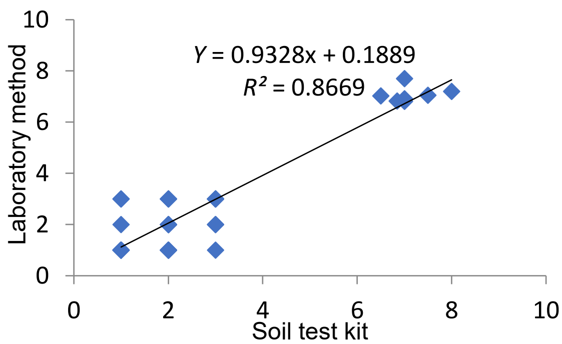

Figure 1: Graphical representation of regression line

CONCLUSION/RECOMMENDATIONS

i. Soil Testing Kit® Transchem, poorly estimated Soil pH and SOC, hence not reliable.
ii. Overall performance of the kit indicated strong agreement with the laboratory method.
iii. The kit can be reliably used to test for N, P and K in Sahel Savannah of Nigeria.
iv. It should be enhanced for estimation of SOC and pH variables either through configured calibration or by using correction factors.
v. Time- and cost-saving advantages of the kit should be quantified by further studies.

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