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RESEARCH ARTICLE

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Development and performance verification of soil testing kit

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ABSTRACT : It was planned to produce a kit by the authors at KVK, Sirsi, UAS, Dharwad during 2009-10. The so developed 'Om kit-Part-I' was released in Krishimela 2010 of UAS, Dharwad. Trials have been conducted during 2009-10, 2010-11 and 2011-12 at KVK, Sirsi (Uttar Kannada district) and during 2011-12 and 2012-13 at KVK, Hanumanamatti (Haveri district). Universal indicator is also available in the market as a ready product. Hence, production of such liquid was tried with available indicators suitable for specific ranges. The combinations were tried. The result is the DHUN indicator. The production of equipment was tried with available electrical devices with standard EC solutions suitable for specific ranges. The combinations were tried. The result is the SLIM stick. The salinity measurement is through this SLIM stick (Salinity Light Intensity Monitor stick). Ranjan Kumar Basak's soil testing methods were modified and brought into this kit method which clearly indicates the per cent of organic matter in soil very easily and quickly. It gives colour development (Orange yellow, olive green and bluish green for low, medium and high organic matter levels).

KEY WORDS : Soil testing kit, pH indicator, Salinity, Organic C

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INTRODUCTION

Soil analysis for pH, EC, Organic C, available NPK CaMgS and Micronutrients are required to take up appropriate measure for better crop yields. And the methods developed should be so simple that a person with little skill should analyse the soils. Review of literature and market information on soil testing kits dates back to 1905. Many such kits are available in the market. Such as HI-MEDIA, NICE and others are providing these soil testing kits(@Rs.2000 to 5000 per kit). The ANGRAU has also released a soil testing kit and it is in use by fertilizer dealers. The BARC, Trombay has also given a method for analyzing soil organic C. There are portable pen type meters for analyzing pH. Many choices for in-field measurement of soil pH are available (Sam Angima, 2010) and EC (Anonymous, 1969) and Organic C (SOCDK method, BARC, 2009). One such company which provides the portable kits is HANNA (@Rs.1500-

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2000 per instrument). However, the response of users is very little. Most of these do not give repeated results. With this background it was planned to produce a kit by the author at KVK, Sirsi, UAS, Dharwad during 2009-10. The so developed 'Om kit-Part-I' as trial pack was released in Krishimela 2010 of UAS, Dharwad. And it was tested during 2010-11 to 2012-13 with an objective of development of simple kit which should produce very nearer to accurate results.

EXPERIMENTAL METHODS

Laboratory trials for development of kit have been conducted during 2009-10, 2010-11 and 2011-12 at KVK, Sirsi (Uttar Kannada district) and during 2011-12 and 2012-13 at KVK, Hanumanamatti (Haveri district). The results are significant and lead to the development of this kit. Soil analysis for basic three parameters *viz.*, pH, EC and Organic C will indicate its general health. The Part- I will have pH, EC and Organic matter content analysis, the other parts will have rest pf the health parameters. The Part-I kit has been developed and it is named as 'Om soil testing kit (Part-I)'. With this kit, the person who uses will be able to take appropriate measures for correcting pH, salinity and organic matter status in soil and can also judge quality of water for drinking and irrigation.

Development of easy technology for measuring pH:

There are few methods for testing pH of soil / water. Analysis by equipments in the laboratory needs skilled person and the cost of equipment is around Rs.10000. The pH paper can also be used but it is not going to give accurate results. One method that appears to be promising is by the use of acid-base indicating dyes. Litmus is a sell known example. Many of these dyes are available and in a water solution, a drop of colored solution on paper will indicate by its color the approximate pH value (Anonymous, 1969). Universal indicator is also available in the market as a ready product. Hence, production of such liquid was tried with available indicators suitable for specific ranges. The combinations were tried. The result is the DHUN indicator.

The pH measurement is through an indicator (it is named as DHUN indicator: Dharwad Universal Indicator). This indicator is a mixture of 0.1 g of Methyl red in 50 ml ethyl alcohol and 0.15 g of Bromo Thymol Blue in 50 ml ethyl alcohol. Both are mixed together.

Using bromo thymol blue (BTB) and Methyl Red (MR) indicators. When BTB:MR was 0.15:0.10 (ration w/w), the solution colour for wide variations was interesting, the others were not that much indicative. And it is named as DHUN indicator (Dharwad Universal indicator).

The most important thing is, it gives very good colour variations, through which one can decide pH of soil and water very easily and take appropriate measure.

Methodology for analysis of soil pH :

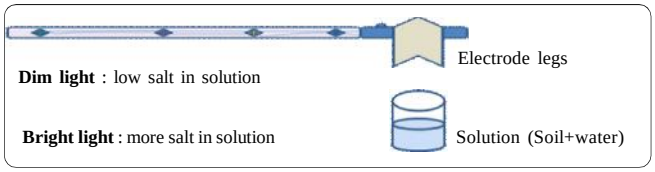
Steps:1. Take 8 g (two spoon) of soil in a beaker. Step.2 Add 20 ml distilled water Step 3. stir well for 10 minutes using glass rod. Step.4 Filter and get clear solution. Step 5. Add five drops of DHUN indicator to it. If pH is acidic the colour will be red. If it is neutral, the colour will be green. If it is alkaline, the colour will be blue. The recommendation of lime (for acid soils) / gypsum (for alkaline soils) is based on the colour intensity referred with standard pH colours which has been given in the kit. The test is same for water also.Very acidic solutions will turn an anthocyanin red whereas neutral solutions will make it purplish and basic solutions will turn it greenish-yellow. Consequently, the colour an anthocyanin solution turns can be used to determine a solution's

pH a measure of how basic or acidic a solution is (Anonymous, 2012).

Development of easy technology for measuring salinity :

There are few methods in testing salinity level of soil / water. Analysis by equipments (EC meter) need skilled person and the cost of the equipment is around Rs. 5000-6000. Portable pocket electrodes are available in the market. But cost is higher. These electrodes directly measure soil conductivity. The range can be calibrated at one point and are designed to be performed in a standardized solution (Anonymous, 2015). Simple, easy and cheaper low cost device is essential. Hence, production of such equipment was tried with available electrical devices with standard EC solutions suitable for specific ranges. The combinations were tried. The result is the SLIM stick. The salinity measurement is through this SLIM stick (Salinity Light Intensity Monitor stick). This is a simple instrument made out of electrical devices (Stick light, batteries, clips and wires). Here the glowing of LED light is directly proportional to the salt level in the liquid.

Made with locally available electrical device, light sticks which are used by children to play :



The basic principle here is the pure water does not conduct electricity. That to current developed in the salt solutions is only in milliamps. Hence, to measure such a low current a device is necessary which can understand this type of low current. Such device is a small light sticks with LED bulbs. Here, the LED bulb glows depending on current developed in the solution. If the current is low (salt level is low), then it glows very dim. If the current is higher (high salt level), then it glows bright. The standard salt solutions from 0.0 to 60.0 dS/m may be prepared (0.5 g KC_l / liter will give 1.0 dS/m) and used for comparing the light intensity. Since it monitors light intensity based on salinity, it is named as SLIM Stick (Salinity Light Intensity Monitor stick).

Measurement of salinity level :

Steps:1. Take 8 g (two spoon) of soil in a beaker. Step.2 Add 20 ml distilled water Step 3. stir well for 10 minutes. Step 4. Then dip the clip legs of SLIM stick in the top liquid portion. If the salinity is low, then the LED light (green / red / blue) glows very dim. If it is high then glows strongly. To compare the salinity level standard solutions are used which have been given in the kit (Thumb rule : 0.5 g salt per liter gives EC 1.0 dS/m). After knowing the salt level, if light is dim, then application of potash is required more. If light glows strongly, then its removal by irrigation and drainage is essential.

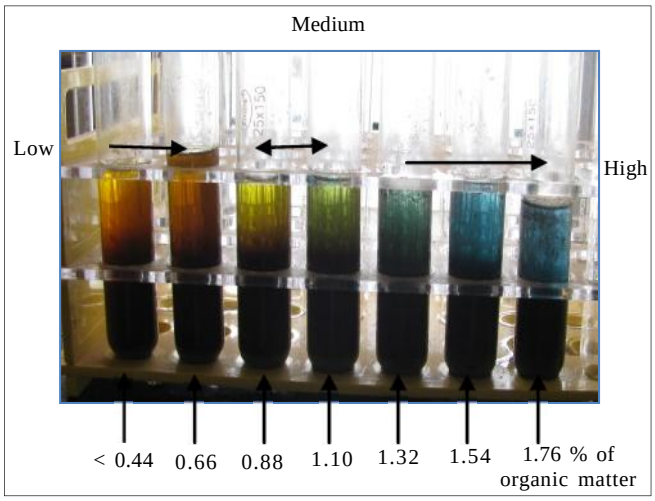
Development of easy technology for measuring organic matter status in soil :

The soil rganic matter is not directly tested in the laboratory. It is worked out from organic C by multiplying with 1.723 factor. The organic C is tested in lab by standard Waklay and Blacks wet oxidation method (1934). Though it is accurate, it needs skilled person to test, require more chemicals and time. Hence, production of such method was tried with available standard procedures (Basak, 2006). The combinations were tried. The result is the Om reactor. The organic matter status is tested through this Om reactor (Organic matter reactor: consists 3 reagents). This is a simple method consists 1. PDC reagent (1.0 N $K_2Cr_2O_7$) 2. Gamla reagent (Gandhakamla / Sulphuric acid, Conc., added with 1 g $AgSO_4$/lit.) 3. Distilled water. Here the development of green colour is taken as a measure of Organic matter level in soil.

Testing of organic carbon in soil using Walkley and Black's wet oxidation method (Piper, 2005 and Jackson, 2014) is used in all the laboratories. One such method is given in Ranjan Kumar Basak's book 'Soil testing and recommendations' which is easy, quick and suitable to common man. In this book, the method involves the addition of few milliliter of two reagents. However, in this Ranjan's method it is difficult to judge with low volumes and the end colours are not distinctive. Hence, Ranjan Kumar Basak's method was modified and brought into this kit method which clearly indicates the per cent of organic matter in soil.

The Om kit method is as follows : 1. Take 4.0 g of soil (one spoon of 0.5 mm sieved soil) in a 50 ml test tube 2. Add 10.0 ml of potassium dichromate (mix the soil and reagent) 3. Then add 8.0 ml of Sulphuric acid, slowly by side wall of test tube. Leave 5 minutes. 4. Then add 20 ml distilled water. Mix water with colour of top solution

(do not mix soil). Observe for colour development (Orange yellow, olive green and bluish green for low, medium and high organic matter levels).



Standard Organic C solutions were developed using L-Ascorbic acid ($C_6H_8O_6$) and multiplied by 1.723 for converting it into Organic matter form.

Measuring organic matter level in soils :

Steps:1. Take 8 g (two spoon) of soil in a test tube. Step.2 Add 10 ml PDC reagent (do not shake) Step 3. Add 8.0 ml Gamla reagent slowly from wall side of the tube. Step 4. Then add 20 ml distilled water to it. Observe the colour developed. If it is orange yellow, the organic matter is low, if it is olive green, the organic matter is medium and if it is bright green / bluish green, the organic matter is high.To compare the organic matter level, standard solutions of L-Ascorbic acid ($C_6H_8O_6$) are used. The colour chart developed from these has been given in the kit. After analyzing organic matter level, looking into the kit recommendations required quantity of organic matter is to be applied to fill the gap. Nearly 13.0 tons of

Table 1 : Analysis of soil pH, EC and organic C by different methods

Sr.No.	Sample ID	Soil pH (1:2)			EC dS/m (1:2)			Organic matter %		
		T_1•	T_2•	T_3•	T_1•	T_2•	T_3•	T_1•	T_2•	T_3•
1.	KVKBi-1	5.72	6.00	5.50	0.14	0.25	0.05	0.59	0.66	0.55
2.	KVKBi-2	5.84	6.00	6.00	0.23	0.25	0.25	1.12	1.10	1.10
3.	KVKBi-3	7.53	7.50	7.50	0.58	0.75	0.50	1.38	1.32	1.32
4.	KVKBi-4	7.96	8.00	8.00	1.20	1.00	1.50	1.93	1.76	1.76
5.	KVKUk-1	5.64	6.00	5.50	0.12	0.25	0.05	0.43	0.44	0.44
6.	KVKUk-2	5.45	6.00	5.50	0.25	0.25	0.25	1.17	1.10	1.10
7.	KVKUk-3	5.68	6.00	5.50	0.45	0.50	0.50	1.55	1.54	1.54
8.	KVKUk-4	5.56	5.50	5.50	0.56	0.75	0.50	2.58	1.76	1.76
9.	KVKUk-1	5.64	5.50	5.50	0.20	0.25	0.25	0.43	0.66	0.44
10.	KVKSh-2	5.52	5.50	5.50	0.42	0.50	0.50	0.78	0.88	0.66
11.	KVKSh-3	7.92	8.00	8.00	0.62	0.75	1.00	1.17	1.10	1.10
12.	KVKSh-4	7.81	8.00	8.00	0.80	1.00	1.00	1.55	1.54	1.76
13.	KVKHa-1	6.56	6.50	6.50	0.15	0.05	0.25	0.78	0.88	0.88
14.	KVKHa-2	6.41	6.50	6.50	0.50	0.50	0.50	1.21	1.10	1.10
15.	KVKHa-3	8.56	8.00	6.50	0.89	0.75	1.00	1.90	1.76	1.76
16.	KVKHa-4	8.32	8.00	6.50	1.20	1.00	1.00	2.76	1.76	1.76
17.	KVKCh-1	6.58	7.00	6.50	0.50	0.50	0.50	0.52	0.66	0.66
18.	KVKCh-2	6.49	6.50	6.50	0.92	1.00	1.00	1.03	1.10	1.32
19.	KVKCh-3	8.56	8.50	8.50	1.20	1.00	1.00	1.38	1.32	1.10
20.	KVKCh-4	8.48	8.50	8.50	1.60	1.50	2.00	1.72	1.76	1.76
21.	KVK Kp-1	7.56	8.00	7.50	0.50	0.50	0.50	0.43	0.44	0.66
22.	KVK Kp-2	7.85	8.00	8.00	2.50	3.00	2.00	0.78	0.88	0.88
23.	KVK Kp-3	8.91	9.00	9.00	4.90	4.00	4.00	1.21	1.10	1.10
24.	KVK Kp-4	8.56	8.00	8.50	10.20	10.00	10.00	1.55	1.76	1.76
S.E.±			0.56			0.06			0.10	
C.D. (P=0.01)			NS			NS			NS	
r value		-	0.98	0.90	-	0.99	0.99	-	0.92	0.90
r square		-	0.95	0.80	-	0.99	0.99	-	0.85	0.81

• (T_1-testing by Standard method, T_2-testing from Om kit by scientist and T_3-testing from Om kit by farmer) NS=Non-significant

organic matter is necessary to maintain 1.3 per cent in soil (0.75 Organic C) as one acre furrow slice weighs one million kg soil. In 3- 4 years it is possible to raise organic matter status to this 1.3 per cent level by continuous application of composts.

Soil testing by standard method and Om kit :

The 24 soil samples from KVK, Bidar (Zone 1 and 2), KVK, Shimoga (Zone 7), KVK, Uttar Kannada (Zone 9 and 10), KVK, Haveri (Zone 7), KVK, Chitradurga (Zone, 4) and KVK, Koppal (Zone 3) have been collected and analysed for these three parameters (pH, EC and organic matter status) by standard procedures (T_1-testing from standard method) and by the Om kit (T_2-testing from Om kit by scientist). It has been tested by a farmer also (T_3) and indicated their analysis report which has been recorded. The data has been analysed for statistical significance by applying CRD and correlation between the treatments (Devdas *et al.*, 2013). Similar work on soil testing towards sustainable agriculture and land management on farmer beliefs and attitudes was also done by Singh *et al.* (2013).

Statistical analysis :

The statistical analysis of soil samples of various places indicated that though the Om kit method is colorimetric (for pH and Organic matter) and light intensity measurement through eyes (for EC), it gives very nearer to accurate results as analysed by the standard methods (CD is NS and r^2>80%). And this kit method is easy, simple and quick. The cost of this Om kit Part I including bag and booklet, works out to be Rs.900 per kit which includes, glassware's and accessory materials from which 60 samples can be tested. After completion of chemicals it is necessary to procure only chemicals and consumables as 'refill kit'. The cost of refill kit is Rs.300.

Based on the soil test results one can take up appropriate measures to improve the soil status. In the kit, a booklet is given (both in Kannada and English) for reference with procedures and recommendations. The kit so developed is named as 'Om soil testing kit (Part – I)'. It is ready for use and available with the first author.

Release of trial pack of "om soil testing kit"in Krishi Mela 2010 of UAS Dharwad

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