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Brajendra
ICAR-IIRR, Rajendranagar, Hyderabad, Telengana, India

V Ravindra Babu
ICAR-IIRR, Rajendranagar, Hyderabad, Telengana, India

Correspondence
Brajendra
ICAR-IIRR, Rajendranagar, Hyderabad, Telengana, India

Rapid method of soil health testing

Brajendra and V Ravindra Babu

Abstract
A healthy soil is one that is capable of supporting the production of foodgrains to a level and with a quality sufficient to meet human requirements, together with continued delivery of other ecosystem services that are essential for maintenance of the quality of life for humans and the conservation of biodiversity. Soil testing is key to balanced fertilization and plant nutrition. The analytical works in a soil testing laboratory mainly involves standard chemical methods suitably modified to permit handling of large number of soil samples with the required degree of accuracy and speed. Rapid soil testing kits are similar to the clinical testing and diagnosis in medicine. These kits are developed to simplify the soil chemical analysis for ready use by the less skilled personal in the rural areas by the soil testing laboratories and rural service centers.

Keywords: rapid method, soil health, testing

Introduction
The concept of soil quality emerged in the literature in the early 1990s (Doran and Safely, 1997; Wienhold *et al*., 2004) [1, 2], and the first official application of the term was approved by the Soil Science Society of America Ad Hoc Committee on Soil Quality (S-581) and discussed by Karlen *et al*., (1997) [3]. Soil quality was been defined as ''the capacity of a reference soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.'' Subsequently the two terms are used interchangeably (Karlen *et al*., 2001) [4] although it is important to distinguish that, soil quality is related to soil function (Letey *et al*, 2003) [5], whereas soil health presents the soil as a finite non-renewable and dynamic living resource (Doran and Zeiss, 2000) [6]. Because of the numerous alternative uses of soil as a living resource, the meaning of the terms soil health and soil quality depend on the defined purpose such as for agricultural use (Andrews and Carroll, 2001; Doran and Parkin, 1994) [7, 8]. There are two ways in which the concept of soil health (or the closely related concept of soil quality) has been considered, which can be termed either 'reductionist' or 'integrated'. The former is based on estimation of soil condition using a set of independent indicators of specific soil properties—physical, chemical and biological. In most parts of the country. Besides the three primary nutrients (N, P, K), deficiency of Sulphur and micro nutrients like Zinc and Boron in many of States, and of Iron, Manganese and Molybdenum in some States, has become a limiting factor in increasing food productivity. Consumption of nutrients by 2011-12 is projected at 25 million tonnes of NPK, and if the existing trend is allowed to continue, it may aggravate imbalances and deficiencies of more nutrients in new areas. Timely corrective action, therefore, necessitates balanced use of fertilizers (National Project on management of Soil Health and Fertility, 2008, Department of Agriculture & Cooperation Ministry of Agriculture Government of India). Data from the farmers' fields (1999-2003) showed decreasing response to fertilizer to around 8-10 kg grain/kg fertilizer. Recovery efficiency of fertilizer nutrients has been around 20-40, 15-20 % and 40 -50% for N, P and K, respectively while that of secondary and micronutrients are substantially low (5-12) which has impacted the production costs with serious environmental consequences.

Rapid Methods of Soil Analysis vis a vis Laboratory methods
Many analytical operations are carried out more conveniently with the help of common as well as sophisticated instruments. This mode of soil testing in laboratory usually takes few days to weeks and the farmers often have to travel long distances to submit the soil samples. Rapid soil testing kits are similar to the clinical testing and diagnosis in medicine. The inadequate availability of soil testing equipments or laboratories and trained manpower is making the soil testing programme more serious at the individual plot or farm level. To assess the ground situation in large tracts of the field/plots, it is pertinent to generate more information about the fertilizing capacity of the land and soils as early as possible.

Rapid soil testing kits are similar to the clinical testing and diagnosis in medicine. These kits are developed to simplify the soil chemical analysis for ready use by the less skilled personal in the rural areas by the soil testing laboratories and rural service centers. These soil testing kits are developed particularly keeping in view soil testing requirements of the less skilled farmers/stakeholders or extension functionaries. The kit provides rapid testing techniques for soil physical, chemical and biological parameters. Soil quality or health integrates the physical, chemical and biological component of soil and their interaction. Therefore a minimum set of parameters should be measured. These kits contain a user manual to follow the method of determination. The kits contain a kit box made up of wood/plastic bags with several plastic bottles having reagents of specific determination which are marked by numerical numbers/or symbols. It also contains scoop, syringe, beaker, graduated test tubes, filter papers, funnel, droppers, spoon, etc. These kits are designed for on-form testing by a semi-skilled person who can test his own soil as often and in as many places as he feels necessary and after causing the need of soil he can apply fertilizers as required. These soil test kits can easily be transported to the field and on-farm soil testing can be done. The rapid method of analysis by these kits involves principles of dye indicators or colour development or by rapid titration. Several colour charts are developed and the colour developed by extracting the soils are matched for their low medium and high categories. These kits generally involve qualitative method of analysis and this is where they differ from the instrumental method of analysis as they are quantitative in nature. In rapid method of analysis the user may not get usually the exact value of the analysed nutrient. However, for a general assessment these methods are quite good and very easily can be applied under field conditions.

ICAR-IIRR kit vis a vis other kits developed

The rice soil quality kit developed by ICAR-IIRR is useful for carrying out soil testing in neutral to alkaline soils. ICAR-IIRR soil quality kit developed will particularly address the problem of non-availability of quality soil testing equipments or laboratories across districts and villages. Further aim of the kit is to simplify the soil chemical analysis for ready use by the less skilled personals in the rural areas by the soil testing laboratories and rural service centres. The kit provides rapid testing techniques for soil physical, chemical and biological parameters. Clearly defined and contrasting visual color matching system has been developed which sometimes distinguishes from ppm level in case of available ammonium status to as high as 50 kg/ha range in case of available potassium status testing. The basic principle of extraction and estimation has not been undermined and most of the soil available nutrient status estimation involves the principle of reagent systems and extraction procedures based on the respective extraction. Colorimetric test methods are used for most test factors. The Soil quality testing kit offers simplified methods for determination of available nutrients from soils and is rapid, fairly accurate chemical tests. Some of the methods adopted in the kit has been detailed below.

We will take some examples how these kits work differently from other kits developed by several stakeholders

Bulk density

Rice soils are unique and are subject to dynamic changes due to puddling/submergence. It is directly related to the compaction level of the soil. The bulk density indicator is measured with the dry mass per volume in g/cm3 or g/ml. There are several methods, from the simple to the sophisticated, to measure the bulk density of the soil. In ICAR-IIRR soil testing kit, we have devised a simple yet a robust method of BD estimation which is the quickest way to estimate it. Also the main merit is a simple, measuring cylinder is what is required to measure it. This method cannot compete with other more accurate laboratory measurements. It is mostly applicable for sandy soils or light textured soils, however, fine soils should be measured only when it is dried and in the method, a well dried ped or small clod should be selected as sample. This test is accurate for single grained sandy soils or skeletal soils and is not suitable for wet soils.

pH

This is a very useful measurement in soils because, amongst other things, pH and nutrient availability are connected. The easiest way to measure pH in soil is to use test strips. The pH-Fix strips and other companies test strips measures at pH 4.0 to 10 and cover a suitable range. The color chart indicates the pH numeric value of the sample. They are best used in moist soil. A pH tester that can measure pH in a slurry or in moist soil will give the most reliable results. In most of the soil samples according to obtained color, the soil sample belongs to one of the three main groups: alkaline, neutral or acidic. The Neutral point is 7.0 and the neutral range is between 6.0 and 8.0 (With other pH test methods, which are able to indicate decimal values, this range would be considerably less). pH value less than 7.0 are considered acidic and values higher than 7.0 are considered to be an alkaline. In ICAR-IIRR soil testing kit, we have adopted the same soil: suspension concentration as done with the measurement of a pHmeter. The dilution ratio fixed is 1:2. In the filtered supernatant liquid a drop of dye solution is added and the colour developed is matched against clearly defined and contrasting visual color matching system for soil pH. The limitation of ICAR-IIRR soil testing kit is it will measure only from pH 6.5 to 12. The main merit is it will measure a gradation of 0.2 to 0.5 unit s difference in pH. The kit is also useful in measuring ph of water, streams and wastes which is in liquid form. The visual colour system developed is unique and new and has been well validated across soils and ecologies and systems and has been found to be perfectly working.

Soil available nutrients (Nitrogen, Phosphorus, Potassium, Sulphur)

To perform the different tests, better advised is to use dry and sieved soil samples. The kit uses neutral normal ammonium acetate solution to extract soil potassium followed by filtration as in the case of N, K, S. Available Nitrogen, potassium, and sulphur analysis uses an extraction method similar for all the three tests and uses neutral normal ammonium acetate solution as extracting solution. For Nitrogen analysis, most of the testing kit chart, the available nitrogen in the soil sample is quantified in trace, low, medium and high levels. However, the ICAR-IIRR kit Clearly defined and contrasting visual color matching system ranging from 0.1 ppm to >6 ppm ranges can be estimated which is fairly enough to measure soil available ammonium status. Generally the ammonium concentration in the soil varies between 2 and 6 ppm. Ten ppm or more occurs in extremely wet soils or in soils that contain fertilizer residue. For estimation of available phosphorus, the kit uses Olsen reagent solution to extract soil

phosphorus followed by filtration. This method is same for extraction in case soil pH. varies from neutral to alkaline ranges. In most of the soil testing kit available in India, the Phosphorus Color Chart allows soil samples to be classified into four groups based on the phosphorus content of each group. However, in ICAR-IIRR soil testing kit Clearly defined and contrasting visual color matching system ranging from 2.5 kg/ha to 30 kg/ha ranges can be estimated which is fairly enough to measure soil available phosphorus. Likewise, for available potassium status, Clearly defined and contrasting visual color matching system ranging from 50 kg/ha to 200 kg/ha ranges can be estimated. For available sulphus status which utilizes the principles of turbidity estimation, contrasting visual color matching system ranging from 5 ppm to 30 ppm ranges can be estimated.

Soil Respiration

The activity of organisms in the soil is considered to be a positive attribute for soil quality. A high soil respiration rate, indicative of high biological activity, can be a good sign of rapid decomposition of organic residues into nutrients available for plant growth. Biological activity is a direct reflection of the degradation of organic matter in the soil. The method adopted in ICAR-IIRR kit is the same as trapping the evolution of carbon dioxide and titrating it with an alkali using phenpthalein as an indicator. ith the present kit user can perform as many samples as he wishes for soil physical characteristics but for all soil chemical, fertility and biological tests about 30-40 samples can be performed. A farmer can generate his own soil health card also after analysing his sample. After exhaustion of the chemicals they can easily take it from soil science division of ICAR-IIRR, Hyderabad. The most important feature of the kit is that even a farmer and a less skilled/educated person will be easily carrying out such testing. he ease in operation and portability to far flung areas/villages coupled with the kit requiring no electricity/power to operate, will be immensely beneficial to the small, marginal, poor farmers and other resource poor stake holder of the region as it will bring soil health assessment to the plot or farmer level.

Limitations of the Kits

1. Best works or only works in soils having neutral to alkaline soil pH
2. Dyes are very sensitive and storability for a longer period under altered conditions is a problem
3. Kits measured values have not been established related to crop production or any management practices and interpretation of soil quality values has not been measured vis a vis soil quality management for a given condition.
4. Careful handling is required as some parameters involves specific mixing/acid mixing and alterations can pose health hazards
5. Some results may vary depending upon the way analysis has been carried out. However, strict compliance of the manual will yield results comparable to best results obtained in the laboratory.

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