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Soil testing - an important tool for assessing soil health and quality

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ABSTRACT

Soil testing plays a very important role in diagnosing the physical, chemical and biological properties of the soils by providing the conditions of available nutrients which indicates the fertility and productivity of the soils. It also helps in assessing the capability and suitability of land for agriculture and allied activities and quantifies the soil constraints. Excessive use of fertilizers especially nitrogenous and phosphatic fertilizers leads to environmental pollution such as eutrophication and nitrate toxicity of ground water. Therefore, soil testing provides sound information for recommendation of fertilizers and correct amount of chemical fertilizers to be integrated with organic amendments for improving the soil health and quality in order to increase the productivity per unit area.

Key words: Soil testing; tool; fertilizers; soil health; quality.

INTRODUCTION

The future of our food security depends upon the attention we pay to soil health care and the conservation and efficient use of water.[1] Doran and Parkin defined soil quality as "the capacity of a soil to function, within ecosystem and land use boundaries, to sustain productivity, maintain environmental quality, and promote plant and animal health."[2] In general, soil health and soil quality are considered synonymous and can be used interchangeably. The concept of soil health deals with the integration of the physical, chemical and biological components of the soil.[3] Thus, to assess this soil health attributes soil testing is the only tool used to measure the physical, chemical and biological health of the soil. Though it aims at diagnosing total health of soil, the present context however, deals only with nutritional aspects of soils in most of the soil testing laboratories. Soil testing provides sound information about the fertility and productivity of the soils. Though chemical fertilizer is an indispensable factor in modern agriculture, an excessive use of the same not only affects soil and plant health and quality but also economical holdings of farmers as the cost of chemical fertilizers are escalating day by day. Excessive use of fertilizers especially nitrogenous and phosphatic fertilizers leads to environmental pollution such as eutrophication and nitrate toxicity of ground water. Soil testing helps to recommend chemical fertilizers for more judicious use in combination

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with organic manures and bio fertilizers and hence balanced nutrition to crop.

OBJECTIVE

The purpose of soil testing is to assess the capability and suitability of land for agriculture and allied activities, identify and quantify the soil constraints (erosion, surface crusting, compaction poor aeration, high bulk density, acidity, salinity, alkalinity, toxicity of nutrients and agro chemical, deficiencies and chemical fixation of nutrients, low activity of microbes and biocatalyst, reduced biochemical process such as transformation, mineralization and biological nitrogen fixation etc) and to monitor the soil fertility and to recommend fertilizers and amendments to soil. Soil testing gives an answer for poor performance of crop and solution to overcome the same.

HISTORY

In the late 1940s, soil testing became an important practice for determining the need for lime and fertilizer in the United States. This change was brought about by several factors. Mechanization led to increased farm size; and the large-scale use of synthetic N fertilizers led to increased crop yields. As crop nutrient removal increased with these higher yields, soil reserves of certain plant nutrients, particularly P and K, began to be depleted, resulting in nutrient deficiencies and lower yields. In response to these problems, there was a concerted effort to develop soil-testing methods that could identify P and K deficiencies in different regions of the United States. These initial efforts later were expanded to include soil tests for other plant nutrients, such as calcium (Ca), magnesium (Mg), boron (B), sulfur (S), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn). Soil testing now is widely accepted as a valuable tool that can be used to identify the economically optimum rates of nutrients required by most crops. In India it is started during the year 1955-56 with the setting up of 16 soil testing laboratories under the Indo-US operational Agreement for "Determination of Soil Fertility and Fertilizer Use."

PROCEDURES

Soil testing includes sampling and sample preparation, sample analysis, preparation of fertility maps and indices, interpretation of analytical data and recommendation of fertilizers. Despite accurate and precise analysis in laboratory results may not be meaningful if sampling and sample preparation is not of technical specification.

Soil sampling must be scientific and true representative of field under investigation. In general soil sampling is done after harvesting of the crop that to after receiving one or two shower which stabilizes the soil. Soil sampling can also be taken up in standing crop between the crop plant rows. Before sampling one has to go around the field where sampling is to be carried out. Divide the field into nearly homogenous units as the soil is highly heterogeneous body based on soil colour, texture, slope, coarse fragments content, cropping system, management practices, saline, alkali and waterlogged marshy patches. Soil sampling must be done separately in each homogenous unit. Higher the number of sampling spots more will be the accuracy in sampling and minimum number of sampling spots would be 8 to 10 per acre land. While fixing sampling spots in zigzag manner, places near bunds roads channels, trees, compost/manure pits, irrigation sources (open well, bore well etc) and the places where manures are heaped or fertilizers are applied. In each homogenous unit samples are drawn from each sampling spots. V shaped pit of desired depth (0-25 cm for shallow rooted crops and 0-25 and 25-50 cm for deep rooted crops) is spaded and a soil slice of 1 inch thick is taken out from freshly exposed inner surface of the pit with the help of khurpi. The soil slice should represent the entire width and depth of pit. The sample col-

lected from each sampling spots are taken in a plastic tray, larger soil lumps are broken by hand when they are moist and then soil is thoroughly mixed. Unwanted materials and undecomposed plant materials are removed. To reduce the bulk sample by quartering technique soil sample is encircled on a plastic sheet and divide it into four parts; two parts opposite to each other along the diagonal are rejected and mixing quartering and rejecting processes continued till soil sample gets reduced to half a kg. Soil sample is dried in shade not in the sun to avoid the transformation of nutrients. Dried sample is transferred to a new and clean cloth bag or polythene cover. And therefore transferred to soil testing laboratory along with the information sheet containing name of farmer, village and taluk, survey no, soil type, crop grown last year and crop to be grown next year and even source of irrigation if soil is irrigated etc. After drying, the soil samples are pounded gently in wooden pestle and mortar and then sieved through 2 mm sieve. The pounding and sieving of soil continues till no soil aggregate remains on sieve except coarse fragment. If the samples are to be analyzed for metallic nutrients and heavy metals the brass, copper and iron sieves must be avoided as these sieves contaminate the soil with metallic ions and it is better to use stainless steel or nylon sieve. The soil sample is mixed and stored in a clean, preferably new plastic or glass containers. Now the soil sample is ready for analysis.

MEANING OF SOIL TEST RESULT

In India, most of the soil testing laboratories analyzed soil reaction (pH), electrical conductivity (Ec), available N, P and K, organic carbon. Fertilizing plants without knowing the soil pH and fertility level is like driving a car in a dense fog and you are never sure where you are. Without knowing the existing fertility level, you are likely to apply too much or too little lime and fertilizer for optimum plant growth as well as the health of the soil. Whenever a soil sample is brought to the laboratory it will first be tested for its reaction (pH). Based on the pH and other relevant soil parameters, chemical or organic amendments are recommended to correct soil reaction and other problems. If the pH of the soil is less than 7 the soil is said to be acidic. As to in-

Table 1. Ratings of available nutrients.

Nutrients	Compounds	Low	Medium	High
N	Alkaline $KMnO_4$ (kg/ha)	<280	280-560	>560
P	Olsen's (kg/ha)	<12.5	12.5-25	>25
K	Ammonium acetate (kg/ha)	<135	135-335	>335
C	Organic carbon (%)	<0.5	0.5-0.75	>0.75
Ca	Ammonium acetate, cmol(p^+)/kg	<1.5	-	>1.5
Mg	Ammonium acetate, cmol(p^+)/kg	<1	-	>1
S	0.01 M $CaCl_2$ (kg/ha)	<22.4	22.4-35	>35
Fe	DTPA extractable (mg/kg)	<4.5	4.5-9.0	>9.0
Mn	DTPA extractable (mg/kg)	<3.5	3.5-7	>7
Cu	DTPA extractable (mg/kg)	<0.2	0.2-0.4	>0.4
Zn	DTPA extractable (mg/kg)	<0.6	0.5-1	>1.0
B	Hot water soluble (kg/ha)	<0.5	1.0-2.0	>2.0
Mo	Ammonium oxalate extractable (pH 3.3) (mg/kg)	<0.2	0.2-0.4	>0.4

crease the pH, agricultural lime such as CaO, $Ca(OH)_2$, $CaCO_3$ are used, gypsum and acidulants sulphur compounds are used to decrease the soil pH to neutral as neutral pH7 is congenial for the growth of most crops.

Based on the soil test results the different nutrient elements can be categorized into low, medium and high as seen in Table 1. From this category, fertilizer recommendation can be done based on recommendation table on the basis of different crops and varieties. This recommendation table varies from state to state, research centres. Calculation can be done accordingly how much fertilizer has to be applied. Naidu *et al.*[5] have discussed with case studies how soil test based fertilizer recommendation can minimize fertilizer misapplication in different agro-climatic zones. For a convenient follow up of the suggestion, district/block maps, showing soil details, should accompany the country maps so that nutrient management recommendations may go along with other soil management recommendations, thus improving soil quality and health.

The quantity and availability of plant nutrient elements in the soil change as a result of removal by the growing or harvested crop, leaching, erosion, or the addition of fertilizer, manure or compost. As soil is a dynamic body and undergoes changes it is advisable to test the soil at least once in three years and every year in case of intensive cultivation for better environmental health and crop nutrition. From all the points cited above we could see the importance of soil testing and if the soils of Mizoram can be tested often with a standard soil testing laboratory, it will help us in achieving scientific land use plans and sustainable development in the years to come and thus restoring the soil health and quality.

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