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Understanding Importance of Soil Testing and Significance of SOC on Crop Productivity

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Abstract

Healthy soils are important to grow healthy crops, raising healthy animals, and supporting a healthy human population through nutritionally balanced diets. As an indicator for soil health, SOC is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs). It supports multiple soil functions determining soil physical, chemical and biological quality parameters contributing to the productive capacity of soil. It improves soil structural stability by promoting aggregate formation which, together with porosity, ensures sufficient aeration and water infiltration to support plant growth. It is one of the factors that help in increasing water holding capacity, improves cation exchange capacity to hold huge quantities of positively charged nutrients such as calcium, magnesium and potassium until the plant needs them.

Keywords: SOC; soil health; quality parameter; plant growth; nutrients.

1. INTRODUCTION

The Agriculture Sector occupies centre stage in Indian economy embodying three thrust areas as to promote inclusive growth, rural income, and to sustain food security. It accounts for nearly 14% of GDP, about 13% of exports and supports half of the country's population as its principal source of income (1). The Green Revolution was initiated in the 1960s by introducing high-yielding varieties of rice and wheat to increase food production in order to alleviate hunger and poverty (2). It has been the major success story of free India. The revolution led to high productivity of crops through adapted measures, such as increased area under farming, double-cropping, which includes planting two crops rather than one, annually, adoption of High yield variety of seeds, overuse of inorganic fertilizers and pesticides, improved irrigation facilities, improved farm implements, crop protection measures and modifications in farm equipment (3) but it also destroyed the diversified gene pool available. The productivity of the crops was increased by the use of fertilizers, pesticides, and groundwater resources. However, mismanagement and overuse of chemical fertilizers, pesticide, and lack of crop rotation caused the land to become infertile affecting the soil health and loss of groundwater became a common occurrence in agricultural areas. These impacts increased expenditure spend on the cultivation of crops with low productivity (2).

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Healthy soils are important to grow healthy crops, raising healthy animals, and supporting a healthy human population through nutritionally balanced diets. Most agricultural soils are depleted of their soil organic matter (SOM) reserves. SOC is the main component of soil organic matter (SOM). As an indicator for soil health, SOC is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs). A high SOM content provides nutrients to plants and improves water availability, both of which enhances soil fertility and ultimately improves food productivity. Moreover, SOC improves soil structural stability by promoting aggregate formation which, together with porosity, ensures sufficient aeration and water infiltration to support plant growth. It is one of the factors that help in increasing water holding capacity. It improves cation exchange capacity to hold huge quantities of positively charged nutrients such as calcium, magnesium & potassium until the plant needs them (1).

Wheat (*Triticum aestivum* L.) one of the second main grain crops in the world is an important staple food which meets most of the protein requirement of the people (4) & is mostly consumed in the form of 'chapati' in India for which bread wheat is cultivated in nearly 95 per cent of the cropped area (5) .The wheat crop requires a well-pulverized but compact seed bed for good and uniform germination (6). Imbalanced fertilization leads to expression of multiple nutrient deficiencies of Zn, Mn, Fe, Cu, Mo and B in the wheat system. To overcome these shortcomings soil health for individual farms needs to be generated for minimizing input costs and maximizing yields. Knowing the fertility status of soil before sowing of crop will lead to proper usage & dosage of appropriate fertilizer, thus maintaining the essential nutrients profile & OC status for optimal crop productivity.

2. NUTRIENT REQUIREMENT OF WHEAT

2.1 Soil organic carbon (SOC): SOC supports multiple soil functions determining soil physical, chemical and biological quality parameters contributing to the productive capacity of soils for wheat production. It improves soil structural stability by promoting aggregate formation which, together with porosity, ensures sufficient aeration and water infiltration to support plant growth. It is one of the factors that help in increasing water holding capacity. It improves cation exchange capacity to hold huge quantities of positively charged nutrients such as calcium, magnesium and potassium until the plant needs them.

2.2 Nitrogen: Nitrogen is usually the most limiting nutrient for wheat production. An inadequate N supply can greatly reduce yield and profit. Too much N can result in lodging, decreased yields and reduced profits. Determining the optimum rate of N fertilizer is the key to maximum economic yields.

2.3 Phosphorous: The central component in plant metabolism is phosphorus. It is an essential part of numerous physiological functions such as energy accumulation and transmission, photosynthesis, respiration, cell differentiation, and cell expansion, which implies energy-rich phosphate compound synthesis as ATP, ADP. Phosphoproteins, nucleic acids, nucleotides, phospholipids, are also essential components (7).

2.4 Potassium: For plants including osmoregulatory, cellular extension, enzyme activation, protein synthesis, photosynthesis, phloem loading, and transport and uptake, potassium is required (4).

2.5 Sulfur: Sulfur is a building block of protein and a key ingredient in the formation of chlorophyll. Without adequate Sulfur, crops cannot possibly reach their full potential in terms of yield or protein content (4).

2.6 Boron: It is essential for cell division and elongation in meristematic tissues, floral organs and for flower male fertility, pollen tube germination along with its elongation and seed/fruit formation. Abundance in B disrupts plant biochemical processes, triggering changes in metabolism and also negatively impacting photosynthesis processes & also impairs photo-oxidant distress resistance (4).

2.7 Zinc: Zn is important for plant growth & an integral part of several enzyme processes (4).

2.8 Other required nutrients: Manganese, iron, molybdenum, copper & Calcium are required for proper plant growth.

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3. SOIL FACTORS THAT INFLUENCE MICRONUTRIENTS AVAILABILITY

3.1 Soil organic matter (SOM): Deficiency of micronutrients is more likely to occur in soils with low SOM. Usually the greater the content of active soil organic matter the greater the availability. This is due to the release of the micronutrients through the decomposition of Organic matter and chelating compounds.

3.2 Soil pH: As pH decreases, the availability of Zn, Cu, Mn, Ni, and B increases. As pH increases, the availability of Mo increases

3.3 Redox potential (soil wetness and aeration): Fe, Cu, and Mn are more available under waterlogged than aerated conditions. In well-drained (aerated or oxygenated) soils, pH controls the availability of Fe and Mn (8).

4. CORRELATION OF OC WITH CROP PRODUCTIVITY

As per the study conducted on randomly selected 50 acres of land to see the effect of SOC (Soil Organic Carbon) and N (Nitrogen) content on the yield in hydoponically grown paddy, it was observed that, a. Fields with %OC between 0.4-0.5 have the highest yield varying from 18.0 qtl/acre - 19.2 qtl/acre, b. Fields with %OC between 0.3-0.4 have the yield varying from 16.5 qtl/acre - 17.4 qtl/acre, c. Fields with %OC between 0.2-0.3 have the yield varying from 15.0 qtl/acre - 16.5 qtl/acre, d. Fields with %OC between 0.1-0.2 have the yield varying from 16.0 qtl/acre - 16.5 qtl/acre. In general, it was observed that SOC has direct bearing on yield of crop, better the OC and N, higher the yield. Every 0.1% increment in OC resulted in 3% - 5% better yield (1).Similar correlation of OC on productivity of wheat crop may also be established.

Soil Health Card (SHC), a Government of India scheme is aimed towards giving the health index of soil & fertilizer recommendations and soil amendment required for the farm (9).

Sl. No.	**Parameter**	**Specifications** **Ref.: Hand Book of Agriculture, Indian Council of Agricultural Research, New Delhi**		
1	**pH**	Normal soil 6.5 - 7.5	Acidic soil <6.5	Alkali soil > 8.5
2	**Electrical Conductivity, EC, (mS/cm)**	Non-Saline 0-0.4	Moderately Saline 0.8-1.6	Strongly Saline >1.6
3	**Available, N (kg/ha)**	Low <280	Medium 281-560	High >560
4	**Available, P (kg/ha)**	Low <12.5	Medium 12.5-25	High >25
5	**Available, K2O (kg/ha)**	Low <135	Medium 135- 335	High >335
6	**Organic Carbon, OC (%)**	Low < 0.4	Medium 0.40 - 0.75	High >0.75
7	**Sulphur, S**	Low <10	Medium 10	High >10
8	**Zinc, Zn**	Low <0.6	Medium 0.6-1.2	High >1.2
9	**Iron, Fe**	Low <4.5	Medium 4.5-9.0	High >9.0
10	**Manganese, Mn**	Low <3.5	Medium 3.5-7.0	High >7.0
11	**Copper, Cu**	Low <0.2	Medium 0.2-0.4	High >0.4
12	**Boron, B**	Low <0.5	Medium 0.5-1.0	High >1.0

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Knowing the fertility status of soil before sowing of crop will lead to proper usage & dosage of appropriate fertilizer, thus maintaining the essential nutrients profile & OC status for optimal crop productivity (9).

5. IMPORTANCE OF SOIL TESTING

5.1 To assess the nutrient status & fertility of soil for providing an index of nutrient availability or supply in given soil (9).
5.2 To determine the problems like acidity, salinity and alkalinity in soil (9).
5.3 To recommend the amount of manure and fertilizer for the crop based on soil test value (9).
5.4 To avoid excessive use of fertilizer and to ensure safety of environment (9).
5.5 Evaluation of the soil suitability for the crop (9).
5.6 Restoration of soil fertility is a key factor for profitability, sustainability and crop productivity (9).
5.7 Identification of nutrients that could be yield-limiting (9).
5.8 Monitoring of soil health properties like pH, EC and OC, that affects the availability of nutrient to crops and thereby improve yields and profit (9).
5.9 Knowledge of the exact deficiency helps farmers to prevent excessive use of money on unnecessary fertilizer application. Hence, soil tests lead to minimization of fertilizer expenditure (9).
5.10 It helps in avoiding soil degradation (9).

CONCLUSION

SOC is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs). As per the study conducted on randomly selected 50 acres of land to see the effect of SOC (Soil Organic Carbon) and N (Nitrogen) content on the yield in hydroponically grown paddy. In general, it was observed that SOC has direct bearing on yield of crop, better the OC and N, higher the yield. Every 0.1% increment in OC resulted in 3% - 5% better yield (1).Similar correlation of OC on productivity of wheat crop may also be established. Soil Health Card (SHC), a Government of India scheme is aimed towards giving the health index of soil & fertilizer recommendations and soil amendment required for the farm. Knowing the fertility status of soil before sowing of crop will lead to proper usage & dosage of appropriate fertilizer, thus maintaining the essential nutrients profile & OC status for optimal crop productivity.

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A Brief Author Biography

Ms. Suruchi Malik- An enthusiastic and fervid professional in microbiology. Completed Post-graduation in Microbiology from CCS University, Meerut in 2020 & PG diploma in food safety & quality management from IGNOU, Delhi. Have 2+ years of experience of analytical testing in chemical & microbiological analysis in Food, Feed, Water, Milk & Milk products. Involved in Research & development activities for food safety & sustainable development.

Dr. Anil Kanaujia- Skilled Scientist with 25+ years of experience in natural product chemistry and medicinal chemistry based new drug discovery research, process chemistry, research on food safety, isolation & characterization of molecules from medicinal plants using Flash chromatography , 1H, 13C and 2D NMR spectroscopic techniques; commercialization of standardized herbal extracts, standardization of polyherbal formulations, analytical research & method development and validation using HPLC-PDA, HPTLC, AAS, UV VIS spectrophotometer etc. techniques. Currently working with the AYURVET RESEARCH FOUNDATION, Sonepat, Haryana, as Head- R&D, managing and providing the guidance on innovative research projects to the team of professionals. Credited with 14 patents (10 US, 1 Chinese, 3 Indian), published 27 research articles in peer reviewed international and national journals.

Ms. Samanwita Banerjee- Skilled and educated professional with M.Sc. microbiology from Bangalore University in the year 2010. Having more than 9 years of experience of performing various microbiological and chemical testing, Research and Development in the areas of research on food safety, analytical research, feeds analysis, Milk analysis, quantification of active ingredient in medicinal plant. Having an experience on Instrumentation such as ELISA technique, UV spectroscopy, Flame photometer, IR moisture balance, STFR machine, etc. Published 6 research articles in peer reviewed international and national journals.

Ms. Surbhi Sharma- An enthusiastic professional in microbiology. Completed Post-graduation in Microbiology from CCS University, Meerut in 2020, having 6 months of experience of microbiological analysis in Food, Feed, Water, Milk & Milk products. Involved in Research & development activities for food safety & sustainable development.

Ms. Kirti Sharma- A passionate, creative & enthusiastic technologist, post graduated from Thapar Institute of Engineering & Technology, Patiala (batch 2018-2020) and graduated from GGDSD college, Chandigarh, have an experience of 1.5 years in chemical testing in quantitative assessment of medicinal plants and animal feed, trained in analysis in field of food quality and pharmaceuticals and also involved in research & development activities of one health.

