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Soil health management and water salinity problems

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ABSTRACT

Management of agricultural soils include the structural, biological and mineral health of the soil, besides N, P and K to produce nutritionally-dense food. The 11th five-year plan (2007-2012) for the first time acknowledged the importance of proper soil management in agriculture. Soil health cannot be determined by measuring only crop yield and water quality but by the evaluation of indicators, which are physical, chemical and biological. The degradation and loss of soil is a problem seriously affecting the production of the world's food crops. Soil disturbance can be the result of physical, chemical or biological activities. Salinity is another major abiotic factor which limits the growth and productivity of plants due to the use of poor quality water for irrigation and soil salinization. The higher the salinity of irrigation water, the higher is its salinity hazard for the crops if the soil and climatic conditions and the cultural practices remain the same. Salt stress is considered as an alarming condition for the ill health of the plant. Proper soil management includes crop rotation, fertilizer applications and irrigation methods which help to decrease the soil exhaustion. Soil Health Card (SHC), a Government of India's scheme is being implemented through the Department of Agriculture of all the State and Union Territory Governments which contains the status of the soil with respect to different parameters. The SHC indicates fertilizer recommendations and soil amendment required for the farm. Scientists in the field of biotechnology are developing hybrid plants that may provide greater yields even in exhausted soil by the use of recombinant DNA technology. Different initiatives are being taken up by the Governments and individuals for solutions to soil loss and exhaustion.

Key words: Soil health, soil disturbance, soil management, soil health card, salt stress

INTRODUCTION

Soil is the network of interacting living organisms within the earth's surface layer which support life above ground. Living organisms in soil ultimately control water infiltration, mineral density and nutrient cycling. Fungi and bacteria help break down organic matter in the soil and earthworms digest organic matter, recycle nutrients, and make the surface soil richer. Management of agricultural soils should consider the structural, biological and mineral health of the soil, besides N, P and K to produce nutritionally-dense food.

The 11th five-year plan (2007-2012) for the first time since India's independence acknowledged the importance of proper soil management in agriculture (Patel, 2016). The concept of soil quality (Doran & Jones, 1996; Karlen *et al*., 1997) is useful to assess the condition and sustainability of soil and to guide soil research, planning, and conservation policy. Soil health cannot be determined by measuring only crop yield and water quality but by the evaluation of indicators. Indicators can be physical (bulk density, infiltration, soil structure, soil depth, porosity and water holding capacity, retention and transport of water and nutrients, habitat for soil microbes, crop productivity potential) , chemical (electrical conductivity, soil nitrate, soil pH, plant and microbial activity thresholds; and available nutrients for plant) and biological (particulate organic matter, soil enzymes, soil respiration, and total organic carbon and microbial activity measure) properties, processes, or characteristics of soils, which can be assessed by qualitative or quantitative techniques. Assessments of soil health are used to support the management of sustainable soils and functions, encompassing both a soil's inherent and dynamic qualities, which impact, are impacted by the surrounding ecosystem, and are subjected to human influence (Hannah *et al*., 2018). Soil-quality assessment, based on inherent soil factors and focusing on dynamic aspects of soil system, is an effective method for evaluating the environmental sustainability of land use and management activities (Nortcliff, 2002).Over a long period of time, no soil can continue to give desired yields without replenishment of the removed nutrients (Patil and Durgude, 2016). Humus is one of the organic soil conditioner which serves as a reservoir for nutrients, improves soil structure, drainage aeration, cation exchange capacity and water holding capacity and provides a source of food for microorganisms (Naik et.al.,2015). Other soil conditioners include vermicompost, crop residues, sewage, sludge, green manure crops and saw dust. Salinity is another major abiotic factor limiting growth and productivity of plants in many areas of the world which is due to increase in the use of poor quality water for irrigation and soil salinization. Plant adaptation or tolerance to salinity stress involves complex physiological traits, metabolic pathways, and molecular or gene networks (Gupta and Huang, 2014). The higher the salinity of irrigation water, the higher is its salinity hazard for the crops if the soil and climatic conditions and the cultural practices remain the same. The Soil gets exhausted when poorly managed soils are no longer able to support crops or other plant life. Soil exhaustion, besides leading to limited food production, also increases risk of soil erosion. Single-crop agriculture depletes soil nutrients because the same nutrients are required year after year and the soil has no time to replenish its stores. Under the Soil Health Card Scheme, a scheme launched by the Government of India in 19 February 2015, the government has planned to issue soil cards to farmers which will carry crop-wise recommendations of nutrients and fertilisers required for the individual farms to help farmers to improve productivity through judicious use of inputs. After testing the soil samples, the experts analyse the strength and weaknesses (micro-nutrients deficiency) of the soil and suggest measures to deal with it. The present paper deals with some discussion regarding the consequences of soil exhaustion and water salinity on plant health and the management of soil health- the role of public and the strategies adopted by the government.

MATERIAL METHODS

An agro ecological approach for soil-quality evaluation and monitoring was proposed by De la Rosa (2005). The assessment was done by evaluating inherent soil quality and dynamic soil quality- the two soil indicators. USDA (2006) has selected seven physical, three chemical, and two biological indicators, which represent a minimal dataset to characterize soil quality.The concept of leaching requirement (LR) was given by Richards in 1954. LR,by definition, is the fraction of total water applied that must drain below the root zone to restrict salinity to a specified level according to the level of tolerance of the crop.

$$LR = \frac{Ddw}{Diw},$$ where D is the depth of water,

;dw and iw refer respectively to the drainage and irrigation water. Assuming strict salt balance conditions in the soil-water system:

Diw x Ciw = Ddw x Cdw where C refers to the concentration of salts.

Therefore,

$$LR = \frac{Ciw}{Cdw} \text{ or } \frac{ECiw}{ECdw}$$

Table 1: Soil attributes which may be used as indicators of soil quality USDA (2006).

Grouping type	Soil indicators
Physical attributes	Soil texture
	Stoniness
	Soil structure
	Bulk density
	Porosity
	Aggregate strength and stability
	Soil crusting
	Soil compaction
	Drainage Water retention
	Infiltration
	Hydraulic conductivity
	Topsoil depth
Chemical attributes	Colour
	Reaction (pH)
	Carbonate content
	Salinity
	Sodium saturation
	Cation exchange capacity
	Plant nutrients
	Toxic elements
Biological attributes	Organic matter content
	Populations of organisms
	Fractions of organic matter
	Microbial biomass
	Respiration rate
	Mycorrhizal associations
	Nematode communities
	Enzyme activities
	Fatty acid profiles

RESULTS & DISCUSSION

According to the LR concept, the excess amount of irrigation water of a known Electrical Conductivity (EC) that must be applied is determined by the maximum permissible EC of the drainage water specified for a particular crop. The values of ECdw represent the maximum salinity tolerated by the species grown under particular conditions. To prevent excessive salt accumulation in the soil, it is necessary to remove salts periodically by application of water in excess of the consumptive use. The excess water applied will remove salts from the root zone provided the soil has adequate internal drainage. Salinity stress involves changes in various physiological and metabolic processes, depending on severity and duration of the stress, and ultimately inhibits crop production (Munns, 2005). Salt stress is considered to hamper the agricultural productivity of soil.

CONCLUSION

Soil isn't an inert growing medium, but rather is teaming with billions of bacteria, fungi, and other microbes that are the foundation of an elegant symbiotic ecosystem. Increasing the diversity of a crop rotation and cover crops increases soil health and soil function, reduces input costs, and increases profitability. Physical soil disturbance, such as tillage, results in bare and/or compacted soil that is destructive and disruptive to soil microbes, and it creates a hostile environment for them to live. Overgrazing, a form of biological disturbance, reduces root mass, increases runoff, and increases soil temperature. All forms of soil disturbance diminish habitat for soil microbes and result in a diminished soil food web. Our intensive industrial agricultural practices - narrow spectrum fertilizers, herbicides, pesticides, large scale monoculture planting and tilling lead to decreasing mineralization, and lowering of humus levels. The produce grown on these soils though looks normal, but is hollow because the mineral content is steadily declining. Thus, proper soil management including crop rotation, fertilizer applications and irrigation methods help in decreasing the potential for soil exhaustion. Rotation of crops not only prevents soil exhaustion but also limits crop diseases and insect infestations.

Governments and individuals are looking for solutions to soil loss and exhaustion. Instead of using pesticides, many farmers now use benign pest-control measures, such as crop rotation, pest traps, and integrated pest management. Conservation tillage or residue management is a conservation practice that gives efficient, effective control to erosion and can improve soil properties and soil quality. Scientists in the field of biotechnology are developing hybrid plants that may provide greater yields even in exhausted soil by the use of recombinant DNA technology.

Conflicts of interest: The authors stated that no conflicts of interest.

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