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Facts of Calcareous Soils

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Abstract

Calcareous soil shares more than 30% soil of the world. A considerable portion of arable land of India is also covered by calcareous soil. These soils have potential to produce good crops. However, due to certain limitation (both physical and chemical) of the soil, a good crop yield is very often not realized. In this article, therefore, characteristics, nutrient constraints and their management in calcareous soil is discussed In this article, the facts of calcareous soil is being focussed, very limited information is available on calcareous soils; hence this article is being written.

Introduction

In the context of agricultural problem soils, calcareous soils are soils in which a high amount of calcium carbonate dominates the problems related to agricultural land use. They are characterized by the presence of calcium carbonate in the parent material and by a calcic horizon, a layer of secondary accumulation of carbonates (usually Ca or Mg) in excess of 15% calcium carbonate equivalent and at least 5% more carbonate than an underlying layer. In the World Reference Base (WRB) soil classification system calcareous soils may mainly occur in the Reference Soil Group of Calcisols.

Further Description

The secondary calcium carbonates are formed under arid or semi-arid climatic conditions when the carbonate concentration in the soil solution remains high. Accumulation starts in the fine and medium-sized pores at the surface of contact between the soil particles. This accumulation may be rather concentrated in a narrow zone of the solum or more dispersed, depending upon the quantity and frequency of rainfall, topography, soil texture and vegetation. In some soils the calcium carbonate deposits are concentrated into layers that may be very hard and impermeable to water (also called “Caliche”). These caliche layers are formed by rainfall (at nearly constant annual rates) leaching the salts to a particular depth in the soil at which the content is so low that the carbonates precipitate. They are also formed by salts moving upward from a water table (caused by irrigation) and precipitating near to the top of the capillary fringe.

General Environment

Calcareous soils are typical soils of semi-arid and arid climates, especially where calcareous parent material occurs in level to hilly land and with a sparse natural vegetation of Xerophytic shrubs and Ephemeral grasses.

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Global Extent and Location

The total extent of Calcisols is estimated at 800 million hectares worldwide, mainly concentrated in arid or Mediterranean climates. However, the total area of calcareous soils is difficult to estimate because many Calcisols occur together with Solonchaks that are actually Salinized Calcisols and/or with other soils of carbonate enrichment that do not key out as Calcisols.

Calcareous Soil

Calcareous soil shares more than 30% of world soil, and their $CaCO_3$ content ranges from a few percent to 95%. In India, calcareous soils are distributed in the states of Rajasthan, Haryana, Gujarat, Punjab, Maharashtra, Uttar Pradesh, Karnataka, Andhra Pradesh, Tamil Nadu, and parts of Madhya Pradesh and Bihar and some union territories (Pal *et al.,* 2000a). The soil spreads over 69.4% (228.8 m ha) of the total geographical area of India. The soils have often more than 15% $CaCO_3$ that may occur in various forms (FAO, 2020). This type of soils normally exists in arid and semi-arid regions on account of relatively less leaching. They also found in humid and semi-humid regions if their parent material is enriched with $CaCO_3$ and are relatively young and has undergone less weathering (Taalab *et al.,* 2019).

Nutrient Constraints in Calcareous Soil

Due to high pH and $CaCO_3$ content of calcareous soil, most of the soil nutrients such as N, P, K, S, Zn, Fe, Cu, Mn and B very often remain less available to plants (FAO, 2020). Generally in alkaline soils (pH > 7), N is lost from soil by ammonia volatilization process, this is further exacerbated in presence $CaCO_3$ in calcareous soil. The native and considerable amount of applied P in calcareous soil remains adsorbed on clay minerals and $CaCO_3$ surfaces, and precipitated as calcium phosphates. Thus, P availability to plants in this type of soil is a major problem. Available K and Mg usually found in adequate amount, however, in some case due to imbalance of Ca, Mg and K ratios deficiency of K and Mg appears in plants. In light textured calcareous soil, leaching loss of SO_4-S occurs. Due to high pH of calcareous soil, lower solubility of micronutrients like Zn, Fe, Cu and Mn occurs, which result in their deficiencies in plants. However, deficiency of B in this of soil is due to its adsorption of $CaCO_3$ surface.

Nutrient Management in Calcareous Soil

To enhance N availability to plants following management strategy is suggested:Nitrogenous fertilizers like ammonium nitrate and ammonium chloride should be used instead of ammonium sulphate and urea.

- Ammoniacal-N and urea should be incorporated into soil through irrigation, or mechanical incorporation.
- Urea should be applied after coating with S, neem oil or converting into large size granules.
- Incorporation of any organics like paddy straw or husk reduces ammonia volatilization.

To combat the P constraint in soil following remedies are advisable:

- Soluble phosphatic fertilizers like DAP and SSP should be used.
- Instead of broadcasting, band application of P is beneficial.
- Organic fertilizers like animal manures, crop residues and enriched compost increases solubility of soil native P.

If deficiency of K is detected application recommended of K, preferably through potassium sulphate is advisable. Similarly, to correct the deficiency of Mg, soil application or foliar application of Mg through magnesium sulphate is recommended. Iron pyrite application meets the requirement for both Fe and S for plants. Besides, foliar spray of $FeSO_4$ or any chelated Fe is also advisable. The deficiencies of micronutrients are normally corrected through soil or foliar application, the doses of which are given in following table.

Table 1: General recommended doses of micronutrient fertilizers

Micronutrient	Material and doses of for application	
	Soil application Foliar spray	Soil application Foliar spray
Zinc	Zinc sulphate (25 kg ha^{-1})	0.5% Zinc Sulphate + 0.25% lime
Iron	Ferrous sulphate (50 kg ha^{-1})	1% Ferrous Sulphate + 0.5% lime
Copper	Copper sulphate (10 kg ha^{-1})	0.1% Copper Sulphate + 0.05% lime
Manganese	Manganese sulphate (10 kg ha^{-1})	1% Manganese Sulphate + 0.25% lime
Boron	Borax (10 kg ha^{-1})	0.2% Borax

The constraints of all nutrients can effectively be managed by adopting integrated nutrient management strategy, which recommends combine use of chemical fertilizers, organic manures and other agricultural beneficial microbes help in nutrient solubilisation and mobilization.

Land Use

The land use of calcareous soils is highly variable: it ranges from non-used wastelands (deserts) to intensively cultivated irrigation areas.

Main Production Constraints

Calcareous soils develop in regions of low rainfall and must be irrigated to be productive. Therefore one of the main production constraints is the availability of water for irrigation. The quality of the irrigation water is of crucial importance for sustainable agricultural production on calcareous soils. Frequently, the irrigation water is the cause of many management problems. Almost all waters used for irrigation contain inorganic salts in solution. These salts may accumulate within the soil profile to such concentrations that they modify the soil structure, decrease the soil permeability to water, and seriously injure plant growth.

Crusting of the surface may affect not only infiltration and soil aeration but also the emergence of seedlings. Cemented conditions of the subsoil layers may hamper root development and water movement characteristics. Calcareous soils tend to be low in organic matter and available nitrogen. The high pH level results in unavailability of phosphate (formation of unavailable calcium phosphates as apatite) and sometimes reduced micronutrient availability, e.g., Zinc and Iron (Lime induced Chlorosis). There may be also problems of potassium and magnesium nutrition as a result of the nutritional imbalance between these elements and calcium.

Conclusion

Calcareous soils are soils rich of calcium carbonate which occur mainly in the semi-arid subtropics of both hemispheres. Potential productivity of calcareous soils is high where adequate water and nutrients can be supplied. The management of water and nutrients is the main production challenge. Optimal amounts of water for plant growth have to be provided without wastage, and salts which may affect plant growth have to be controlled. Since, calcareous soil spreads over a considerable portion of world including India; it has significant contribution for food production of the nation. In current scenario, to feed the continuously growing population increasing the productivity of the calcareous soil is extremely important. Thus, keeping the view of above mentioned nutrient constraints and their management practice, development of location specific nutrient management practice is the need of the hour.

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