

Nutrient Management in Calcareous Soils

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In dry regions, presence of CaCO_3 is very common. Formation of CaCO_3 in soils is an important pedogenic process in many arid and semi-arid parts of the world including the Indian sub-continent (Pal *et al.* 2000). It has been observed that when the zone CaCO_3 accumulation coincides with depth of root concentration, it could be an important factor in terms of plant nutrition. Many soils of India formed in arid and semi-arid parts are typically calcareous either throughout the profile or within the rooting depth. However, there are many calcareous soils in climates other than arid and semi-arid. Therefore, it is very necessary to identify factors and processes that are related to the genesis of CaCO_3 in soils for precise taxonomic grouping.

Calcareous soils

The calcareous class is listed in the family group of soil classification (Soil Survey Staff, 1999). The control section for the calcareous class could be either of these,

- (i) soils with a root-limiting layer that is 25 cm or less below the mineral soil surface meaning a 25 cm thick layer directly above the root-limiting layer
- (ii) soils with a root-limiting layer that is 26 cm to 30 cm below the mineral soil surface meaning the layer between a depth of 25 cm below the mineral soil surface and the root limiting layer
- (iii) all other listed soils meaning between a depth of 25 and 50 cm below the mineral soil surface.

The Soil Taxonomy (Soil Survey Staff, 1999) again keyed out calcareous soils as those which effervesce (in cold dilute HCl) in the fine-earth fraction in all parts of the control section. It, therefore, appears that the calcareous soils may have CaCO_3 content varying from a small amount in some part of the

profile to an appreciable amount occurring throughout the profile).

Distribution and extent of calcareous soil

In India, calcareous soils are distributed in the states of Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and parts of Madhya Pradesh and Bihar and some union territories (Fig. 1). Patches of these soils have also been reported in the state of Jammu and Kashmir, in the Nowgaon district of Assam and the Jampui hills of Tripura. Calcareous soils are developed on organogenic calcium carbonate (CaCO_3) in the Lakshadweep islands. The estimated area of calcareous soils is 228.8 m ha and covers 69.4% of the total geographical area (TGA) of the country and spreads over 38 out of 60 AESRs (Pal *et al.* 2000).

Calcareous soils are soils in which a high amount of free calcium carbonate dominates the problems related to agricultural land use. They are characterized by the presence of CaCO_3 in the parent material and by a calcic horizon, a layer of secondary accumulation of carbonates of Ca and/ or Mg in excess of 15% CaCO_3 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. Calcareous soil is classified into four groups as per the ratings given by National Bureau of Soil Survey and Land Use Planning (NBSS LUP).

Class	Free CaCO_3 (%)
Non calcareous	Nil
Slight	< 5
Moderate	5-15
Strong	>15

Characteristics of calcareous soils

- Usually have alkaline soil reaction (PH >7.0) and High buffering capacity.
- Soils are dominated by carbonates of calcium and magnesium mainly soil contain CaCO_3 in free form CaCO_3 may occur indifferent forms (powder/nodules) with reduced availability of N, P, K, S, Fe, Zn, and B.
- Iron deficiency due to high CaCO_3 leads to chlorosis also called lime induced iron chlorosis and reduced rate of seed germination.
- Decreased water holding capacity (WHC) due to alteration in soil structure, formation of hard pan.
- Flocculation due to enough Ca and Mg present in calcareous soil increases aggregate stability and when a large percentage (>30%) of CaCO_3 is present in the clay fraction, the soils WHC can be reduced.
- Surface crusting and sub-surface hard pan formed restrict aeration, infiltration and affects rate of seedling emergence and establishment.
- Activity of rhizosphere micro-organisms is reduced under less moisture conditions.

Formation of calcareous soils**In situ by weathering of parent rock materials**

There is formation of calcium carbonate due to weathering of rocks. The low rainfall in arid and semi-arid regions is not sufficient to leach out the soluble products of weathering to ground water. In dry weather, the salt moves up with the water by capillary movement to the surface where they are deposited.

Development of calcareous soil by secondary origin

These are developed in low lying areas generally drainage is impeded in these low-lying areas. During the rainy season, soluble calcium bicarbonate of nearby areas accumulates in the low-lying areas. During dry season, calcium bicarbonate converted into calcium carbonate and deposited on the soil surface by capillary movement.

Main production constraints of calcareous soils

- Calcareous soils develop in regions of low rainfall and must be irrigated to be productive. Therefore, one of the main production

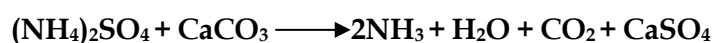
constraints is the availability of water for irrigation.

- 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 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.

Nutrient management in calcareous soils**Nitrogen**

1) Decreased availability of plant nutrients due to alkaline nature.

2) Most of plant nutrients are available when soil pH ranges between 6.5 to 7.5, under high pH of soil the availability of N to plant decreases due to reduced rate of nitrification and loss of N through volatilization process.



3) When ammonical fertilizers are used in calcareous soil, nitrogen is lost in the form of NH_3 as ammonical compounds turn into ammonia after reacting with CaCO_3 in soil

4) Hence, use of ammonium sulphate, ammonium phosphate should be avoided in calcareous soil. Instead of these ammonium nitrate and ammonium chloride is ideal.

Phosphorous

- At pH 6 to 7.5 phosphorus is usually available due to higher pH, availability of P is reduced in calcareous soil and P often turns into tri-calcium phosphate, magnesium phosphates which are less soluble in water.
- As these insoluble compounds are formed after addition of P fertilizers in calcareous soil,

its availability is decreased this is called as P fixation.

- These insoluble compounds are formed and retained within soil. As soil pH increases, rate of formation of these insoluble compounds increases and availability of P decreases.
- Hence, to increase its availability P fertilizers should be added with organic matter and use of PSB is also helpful to increase solubility of P in soil. Easily soluble sources like SSP, DAP should be used.
- Band placement of P fertilizers near to roots and in granular form helps in increasing availability of P. Time of application of fertilizer is very important regarding plant growth. Plant must get right time for development of roots
- Addition of SSP along with FYM/compost to crops helps in increasing P availability and development of roots.

Potassium

- Calcareous soil contains enough amount of potassium but due to higher concentration of calcium, potassium uptake is affected.
- Hence, deficiency of potassium is observed in plants.
- Potassium should be added in quantity more than its recommended dose under high calcium content in soil.

Micronutrients

- The deficiencies of micronutrients are mostly saviour problems of calcareous soil. Calcium carbonates can easily fix all the nutrients and render them unavailable
- Thus, application of micronutrients along with organic manure is helpful in increasing their availability on the basis of soil test value would be helpful in increasing the yield. The deficiencies of micronutrients are normally corrected through soil or foliar application.

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