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# Calcareous Soil and Their Management – A Review

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**Abstract**

Calcareous soils where lithogenic and secondary carbonates are important constituents of the soil mineral matrix abound in many areas. Soil carbonates have been described as an organic matter stabilization agent, mainly due to chemical stabilization mechanisms (Virto*et al*. 2018). Calcareous soils generally have a high carbonate content of the micromass, occurring in the form of micritic or microsparitic crystals. The pH of these soils is usually above 7 and may be as high as 8.5. When these soils contain sodium carbonate, the pH may exceed 9. In some soils, $CaCO_3$ can concentrate into very hard layers, termed caliche, that are impermeable to water and plant roots. Although a calcareous soil may be dominated by free lime, it may also contain significant amounts of zinc (Zn),iron (Fe), aluminum (Al), manganese (Mn) and boron (B) either as discrete minerals, as coatings on soil particles, or complexed with soil organic matter. Thus reclamation and management of calcareous soils are urgent needs to improve soil fertility and crop productivity.

***Key word*** :Calcareous soil, nutrients management, nutrients fixation, micronutrients.

**Introduction**

Calcareous soils are defined as soils containing amounts of calcium carbonate affect distinctly the soil properties related to plant growth, whether they are physical, such as soil – water relations, and soil crusting, or chemical such as the availability of plant nutrients (Taalab*et al*. 2019).Calcareous soils are those which contains enough free calcium carbonate and which gives or produces effervesce on reaction with (0.1N) dilute HCL. Calcareous soils can contain from 3% to >25% $CaCO_3$ by weight with pH values with a range of 7.6 to 8.3. They are relatively widespread in the drier areas, in large part of arid and semiarid regions of the earth. In India, these soils are commonly found in the 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*. 2000). Soils are often very

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fertile, thin and dry. Calcareous soils have often more than 15% $CaCO_3$ in the soil that may occur in various forms (powdery, nodules, crusts, etc.). Water is the most limiting input to making calcareous soils productive. Under the supply of adequate water and nutrients, these soils may prove to be very productive. Calcareous soils are common in the arid areas of the earth (FAO, 2016) occupying >30% of the earth's surface, and their CaCO3 content varies from just detectable up to 95% (Marschner, 1995). Thus, management of calcareous soils are very important for development of soil fertility and crop productivity.

**Characteristics:**

1) Usually have alkaline soil reaction (PH >7.0)and High buffering capacity.
2) 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.
3) Iron deficiency due to high $CaCO_3$ leads to chlorosis also called lime induced iron chlorosis and reduced rate of seed germination.
4) Decreased water holding capacity (WHC) due to alteration in soil structure, formation of hard pan.
5) 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.
6) Surface crusting and sub-surface hard pan formed restrict aeration, infiltration and affects rate of seedling emergence and establishment.
7) Activity of rhizosphere micro-organisms is reduced under less moisture conditions.

**Formation:**

1) These soils are formed form weathering of carbonate rich parent material like limestone, Basalt, dolomite often found in drier areas, where precipitation is lower to leach out soluble salts, results in accumulation of salts throughout soil profile.
2) Soils may become calcareous when irrigated over long term with water containing small amount of dissolved caco3 over period of time. Long term irrigation with water containing small amount of dissolved caco3 also results in formation of calcareous soil.

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**Table 1.**Rating of calcareous soil.

| Content | Class |
|---|---|
| 0.5-1 | Barely Calcareous |
| 1-2 | Slightly |
| 2-5 | Moderately |
| 5-10 | Calcareous |
| >10 | Very Calcareous |

**Management of calcareous soil:**

1) Deep ploughing and green manuring once in two to three years.
2) Application of organic matter / manure every year in recommended quantity for different crop.
3) Application of press mud compost 5 t/ha once in three years before ploughing.
4) Soil analysis/testing for $CaCO_3$ content in different layers of soil profile is necessary before planning of horticultural crops.
5) Application of micronutrients along with organic manure is helpful in increasing their availability on the basis of soil test value.

**Nutrient management in calcareous soil :**

**Nitrogen**

1) Availability of plant nutrients is generally found decreased in calcareous soil due to its alkaline nature/reaction/pH.
2) Most of plant nutrients are available when soil pH ranges between 6.5 to 7.5 under high pH of availability N to plant decreases due to reduced rate of nitrification and loss of N through denitrification process. In soil ammonia converts first to nitrate and then to nitrate and becomes available to plant.
3) Ammonium N fertilizers like ammonium sulfate and ammonium phosphate are useful when pH of soil is less than 7.5 as during nitrification process $H^+$ ions are released which neutralize the $CaCO_3$ and helps to reduce soil pH. But when these ammonical fertilizers are used in calcareous soil, nitrogen is lossed 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 are found

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useful as the loss of N is less when these sources of N are utilized. After knowing initial chloride status of soil, ammonium chloride should be used.

**Overall cares need to be taken for management of N fertilizers in calcareous soil :**

1) To avoid loss of N in the form of $NH_3$, added fertilizers should get mixed well within soil after ensuring proper moisture, fertilizers should be added. If moisture is less, then soon after fertilizers application supplemental irrigation is need to be given.
2) To avoid loss of N in $NH_3$, urea should be added along with MOP or triple super phosphate. Use of sulphur coated or neem coated urea also found beneficial and it improves efficiency of N fertilizers.

**Phosphorus**

1) In general efficiency of phosphorus nutrient ranges between 15 -20 % and in calcareous soil its efficiency and availability is found very low. 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.
2) 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 P decreases. Hence**, t**o increase its availability P fertilizers are need to 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.
3) 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 Pat right time for development of rootsAddition 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 uptake of potassium ion is affected. Hence, deficiency of potassium is observed in plants. For example grapes become too acidic in calcareous soil due to less uptake of potassium. Therefore, potassium should be added in quantity more than its recommended dose under high calcium content in soil.

**Micronutrients**

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The deficiencies of micronutrients are mostly saviour problems of calcareous of soil. Calcium carbonates can be easily fixes all the nutrients (Wahba*et al*. 2019).Thus, addition of micronutrients like, Zn, Cu, Fe, Mn and B would be helpful in increasing the yield. The deficiencies of micronutrients are normally corrected through soil or foliar application (Table 2).

**Table 2.**General recommendations of micronutrient fertilizers(Samal and Kumar 2020).

| Micronutrients | Source of micronutrient fertilizers | |
|---|---|---|
| | For Soil Application | For Foliar Application |
| Zinc | Zinc Sulphate(25 kg $ha^{-1}$) | 0.5% Zinc Sulphate + 0.25% lime |
| Iron | Iron Sulphate(50kg $ha^{-1}$) | 1% ferrous Sulphate + 0.5% lime |
| Copper | Copper Sulphate(10kg $ha^{-1}$) | 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 |

**Conclusion**

Calcareous soil spreads over a considerable portionof world including India and its management is the main challenge. Improved fertilizer management, natural or synthetic conditioners, timely amounts of water scheduling, ploughing, etc.are very important to remove excess salts for growing successfully crops in calcareous soils. Using chelated micronutrients *viz*.Zn, Fe, Mn, Cu and B deficiencies can be corrected through soil and foliar applications. Apply organic manures and other organic sources can be neutralized soluble salt in calcareous soil.

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