Reclamation of calcareous soils

There is formation of calcium carbonate ($CaCO_3$) 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. It has secondary origin in water-logged areas.

Calcareous soils, characterized by high calcium carbonate content, present unique challenges for agricultural productivity. **High pH (generally above 7.5).**

Limited nutrient availability, particularly for micronutrients like iron and zinc.

Poor water retention due to compacted layers.

Calcareous soils are existing in aired and semi aired regions. It is a soil which contains 5% $CaCO_3$, if contains 2.5 % called slightly calcareous soil but if contains 10% called extremely calcareous while if contains more than 10% called very extremely calcareous soil .

The types of $CaCO_3$ are :

1- Active $CaCO_3$. 2- Non active $CaCO_3$.

What are the main problems in calcareous soils?

The problems are:

1. **Availability of Nutrients:**

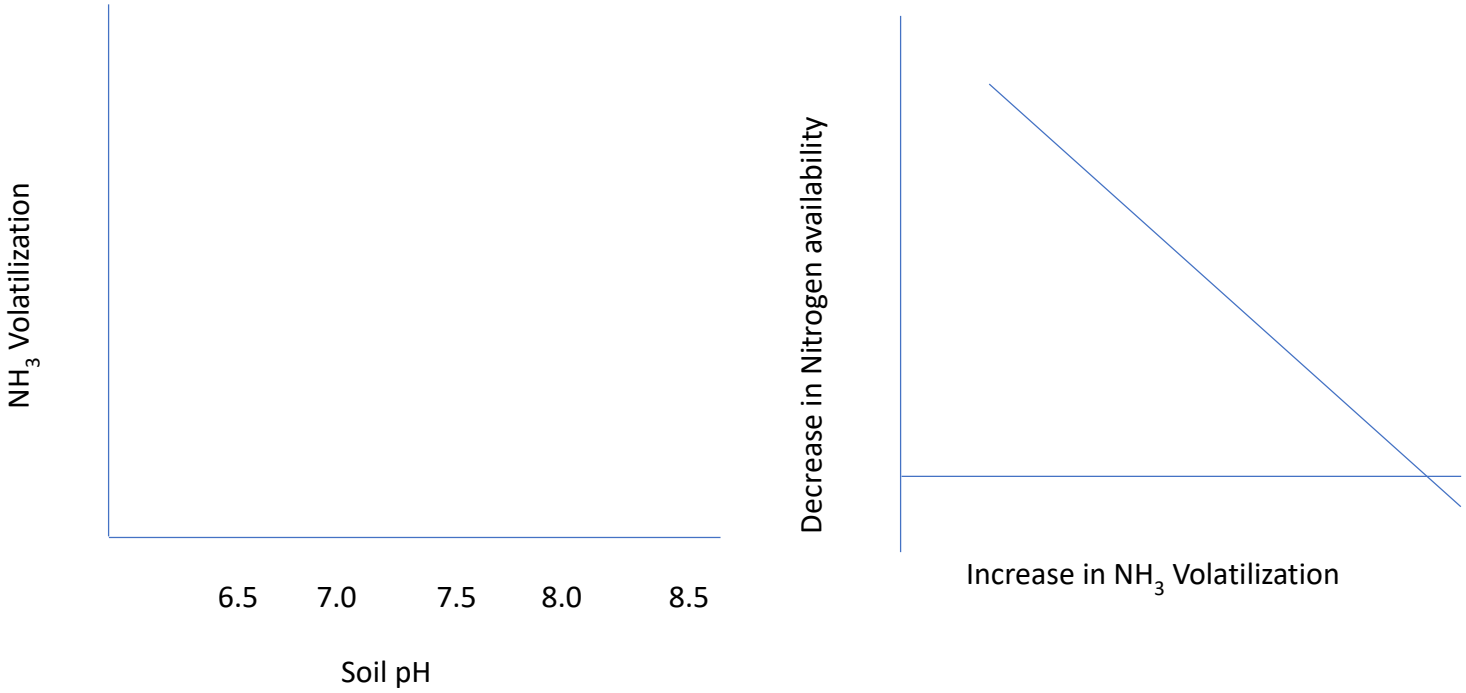
Nutrient Deficiencies: High pH can hinder nutrient uptake, resulting in stunted plant growth.

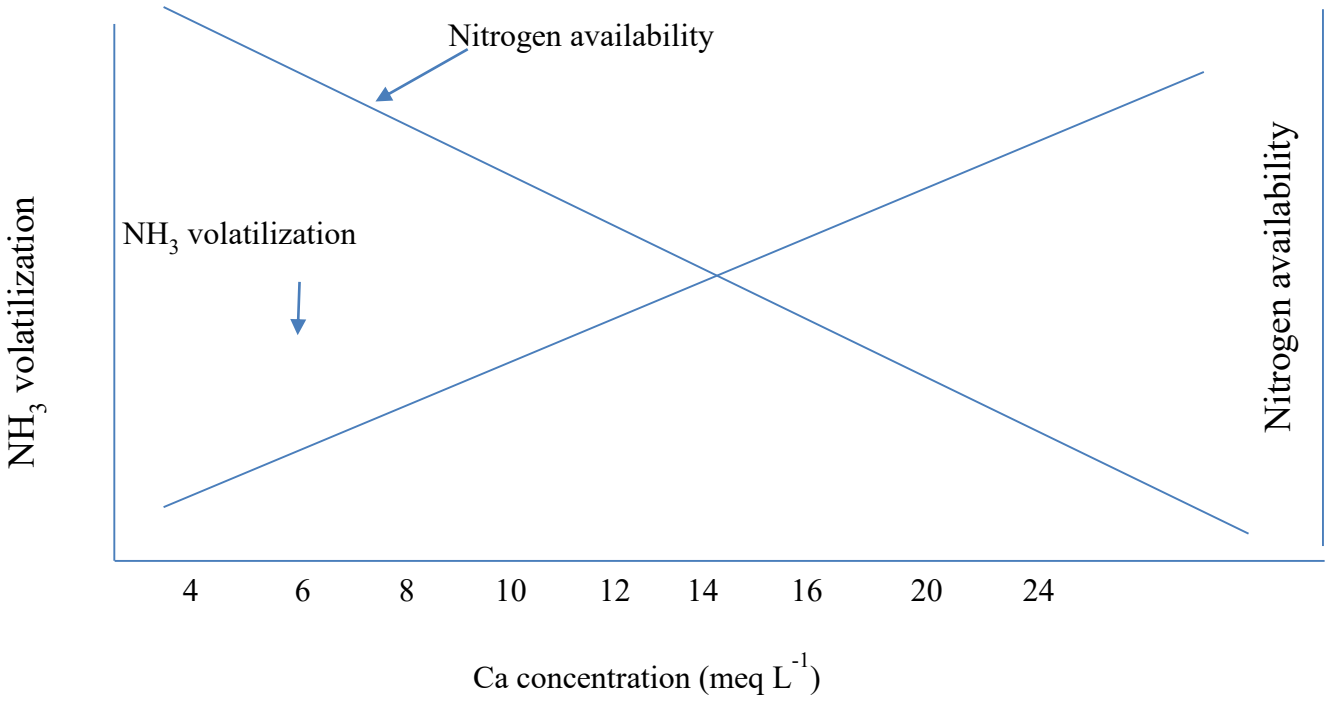
(i) **Phosphorus:**

In calcareous soil, the solubility of phosphorus is depressed which results in the decrease of P availability.

1-Fixation of Phosphorus:
A-Chemical fixation .
B- Physical fixation.

(ii)-Decrease in availability of nitrogen due to increase in volatilization of nitrogen in NH_3 form with increase in Ca and pH.


NH3 Volatilization
6.5
7.0
7.5
8.0
8.5
Soil pH
Decrease in Nitrogen availability
Increase in NH3 Volatilization

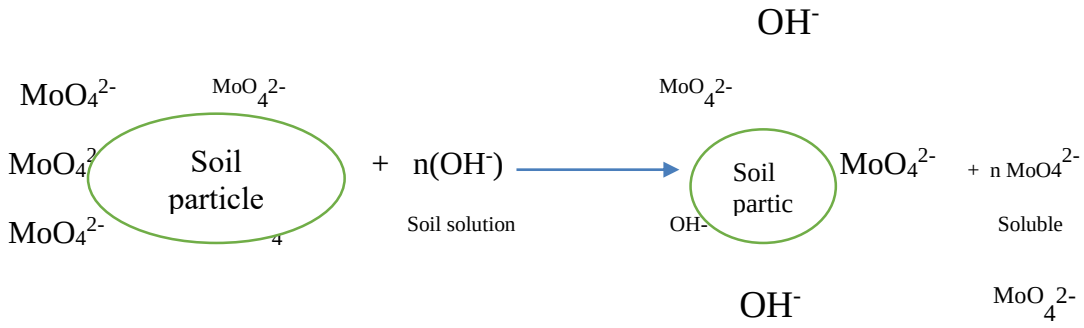

Nitrogen availability
NH3 volatilization
NH3 volatilization
Nitrogen availability
4
6
8
10
12
14
16
20
24
Ca concentration (meq L-1)

3- Potassium availability:

Increase in Ca or $CaCO_3$ causes decrease in potassium availability due to antagonistic relation between them, or increase in Ca causes decrease in potassium activity ratio(KAR).

4- Availability of micronutrients (Fe, Zn, Mn, Cu, B, MoO_4^{2-}).

Increase in Ca or $CaCO_3$ causes increase in soil pH, or (OH^-) in soil solution which replace exchangeable MoO4 by anion exchange this causes conversion of exchangeable MoO_4^{2-} to soluble form then increase its availability as follow:



2- Physical fixation. (**Soil Structure**: Compaction and poor aeration can limit root development)

- (i) Calcareous soils remain in a flocculated condition (granulated). Soil is permeable to water and air due to large number of pore spaces.
- (ii) Flocculation in heavy (clay) soil increases pore spaces and consequently drainage but in light (sandy) soil it decreases water-holding capacity.

3- Activity of Microorganism:
Moisture is essential for microorganism activity. Microorganism activity in wet calcareous soil is normal but it is affected in dry calcareous soil.

Methods of calcareous soils reclamation:

a. Soil Amendments

- **Acidifying Agents**:

- **Elemental Sulfur**: Reduces pH over time, improving nutrient availability.

  Chemical method or acidification (Uses acids): this method is not successful method if soil CaCO3 = 5% or more due to the following reasons:

  A- It is not economic method.

  B- Causes damage of soil structure.

  C-It is very difficult.

- **Organic Matter**: Adding compost or manure enhances soil structure and nutrient content.

b-Gypsum Application:

- When sufficient amount of farm yard manure, compost and green manure are added, the amount of carbon dioxide and acid increases and as a result pH of soil decreases. Helps to improve soil structure, reduce compaction, and enhance drainage.

C-**Biotechnological Approaches**

- **Microbial Inoculants**: Introducing specific bacteria or fungi that can help plants absorb nutrients more effectively.
- **Genetic Engineering**: Developing crops that are more tolerant to high pH and nutrient deficiencies.

D- **Cover Crops and Crop Rotation**

- **Cover Crops**: Planting legumes or deep-rooted species can improve soil health and nutrient cycling.
- **Crop Rotation**: Rotating different crops can help manage soil fertility and reduce pest issues.

E-Irrigation Management

- **Drip Irrigation Systems**: Deliver water directly to the root zone, minimizing evaporation and maximizing efficiency.

Rainwater Harvesting: Collecting and storing rainwater can provide a sustainable water source for irrigation, and decrease time interval between two successive irrigations to avoid surface crust formation.

F- Tillage Operation: Deep plowing if calcic layer is existing.

G-Using chelate fertilizers, and Foliar application of fertilizers

To increase the availability of P, the phosphatase fertilizers should be used in the following manner:

- (a) Phosphates' fertilizers should be used near the roots of plant.
- (b) Use of phosphatise fertilizers in ball form also increases its availability.
- (c) May be used in split dose.
- **(iv) Use of Micronutrients:**
- Addition of micronutrients like, zinc, copper, iron would be helpful in increasing the yield.