

# Unit 2: Soil acidity and liming

**Krishna Poudel**

**Senior Agriculture Instructor**

**Department of Plant Science**

**Shree Triveni Secondary School**

**Province 1, Nepal**

**Contact: +9779847016830**

**[Krishna Poudel \(researchgate.net\)](#)**

**E-mail: [poudelkrishna051@gmail.com](mailto:poudelkrishna051@gmail.com)**

## Soil Acidity:

- \* Soil acidity is a condition in which the soil pH is lower than a neutral pH (less than 7).
- \* Soil pH is a measure of the hydrogen ( $H^+$ ) ion concentration expressed as the negative common logarithm of  $H^+$  concentration.  
i.e.  $\text{Soil pH} = -\log (H^+)$
- \* When soil becomes too acidic it can: **decrease the availability of essential nutrients**, increase the impact of toxic elements, decrease plant production and water use.
- \* The main cause of soil acidification is inefficient use of nitrogen, followed by the export of alkalinity in produce. Ammonium based fertilizers are major contributors to soil acidification.

- \* Soil acidity is common in all regions of moderate to heavy rainfall (e.g. eastern Terai of Nepal) where precipitation is sufficient to leach appreciable amt. of exchangeable non-acid cations) like  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ .
- \* As basic cations are removed, soil tends to become acidic in reaction.
- \* Predominant acid causing cations are  $\text{H}^+$ ,  $\text{Al}^{3+}$  .

## Causes of soil acidity

### 1. Characteristics of parent materials

- Soils formed from the rocks having acidic ions are acidic eg Granite/Quartz
- Soils formed from rocks having basic ions are basic eg. Basalt
- Clay minerals such as Kaolinite, montmorillonite, Fe and Al are acidic in nature

## 2. Accumulation of OM & their decomposition

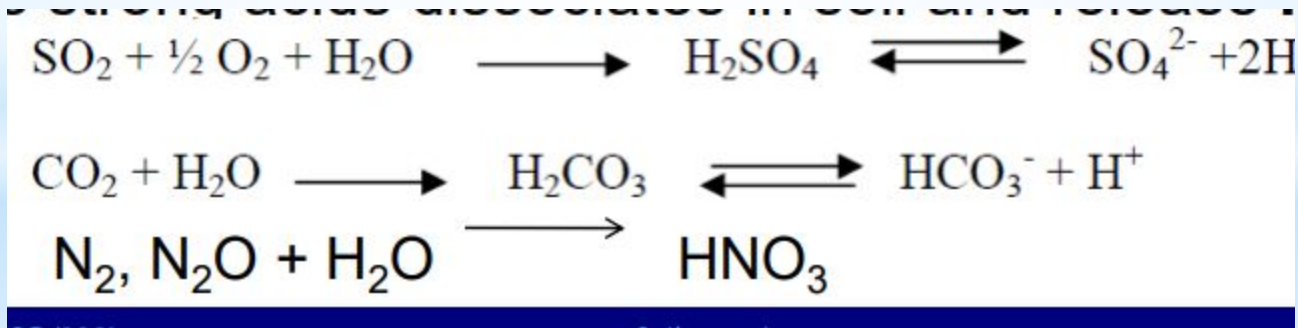
- OM contains numerous acid functional groups from which  $H^+$  ions can dissociate.
- During decomposition, many (in)organic acids are released.
- Slow & persistent action of weak inorganic acids especially of carbonic acid on mineral constituent of soil is responsible for the removal of base forming cations like  $Ca^{2+}$ ,  $Mg^{2+}$ , etc. by dissolution & leaching.

### 3. High rainfall & low evaporation

- Basic cations are more soluble than acidic cations
- Under high precipitation, basic cations ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ ,  $\text{Na}^+$ ) leach out but the acid cations such as  $\text{Al}^{3+}$  &  $\text{H}^+$  tends to retain in the soil surface.
- So surface soil becomes acidic & consequently the sub - surface soil is basic.

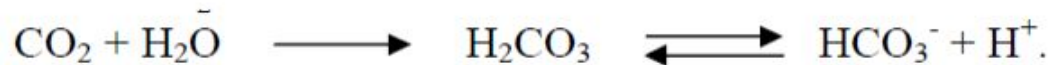
## 4. Acid rain

- Rain with pH value <5 is termed an acid rain.
- The acid rain has pH of about 4-4.5 but sometime as low as 2.
- When raindrops falls through unpolluted air, water reacts with CO<sub>2</sub> & forms weak acids H<sub>2</sub>CO<sub>3</sub> which dissociates & release H<sup>+</sup>
- In polluted air with N & S gases coming from industrial combustion, forest fires, volcanic eruptions, N & S reacts with water forming HNO<sub>3</sub> & H<sub>2</sub>SO<sub>4</sub> .
- These strong acids dissociates in soil and release H<sup>+</sup>, N<sub>2</sub>, N<sub>2</sub>O, H<sub>2</sub>O  
HNO<sub>3</sub>



## 6. Plant residues

- **Root respiration/OM decomposition** by MOs produce **CO<sub>2</sub>**.
- **CO<sub>2</sub> & H<sub>2</sub>O reacts** to form **H<sub>2</sub>CO<sub>3</sub>**; H<sup>+</sup> dissociates
- Because H<sub>2</sub>CO<sub>3</sub> is a **weak acid**, its contribution to H<sup>+</sup> ions is **negligible** when the pH is much below **5.0**.
- This **decomposition of OM is very common in forest soils**.



## 7. Oxidation of nitrogen (nitrification) & sulfur



- Firstly, breakdown of plant residues also involves **oxidation of organic-SH groups** to yield H<sub>2</sub>SO<sub>4</sub>.
- Secondly, reduced sulfur (such as FeS<sub>4</sub>) also release **H<sup>+</sup>**



## 8. Plant uptake of basic cations

- Plants uptake more of certain cations (e.g.  $K^+$ ,  $NH_4^+$  &  $Ca^{2+}$  ).
- For every +ve charge taken in on a cation, a root maintain charge balance either by taking up anion or by exuding cations.
- When they take up far more of cations (Ca, Mg,  $NH_4$ , K ) than they do of anions ( $SO_4^{2-}$ ,  $NO_3^-$ ) (for eg Legumes), plant usually exude  $H^+$  ions into the soil sol to maintain charge balance & contribute to acidification.
- When plant root maintain charge balance by up taking the same quantity of opposite charged ions, it does not change soil P.

## 9. H<sup>+</sup> ions (Root exudates)

- Some H<sup>+</sup> ions excreted by plants are exchanged for nutritive cations such as Ca<sup>2+</sup>, process known as contact cation exchange.

## 10. Crop removal of basic cations

- Some dicot plants such as legumes absorb basic cations thus indirectly causing soil to be acidic.
- Eg. Yield of 13 ton/ha alfa-alfa removes 45 kg Ca and 9 kg Mg

## Liming material and their uses

\*Liming materials are found in 3 major forms :

- i.** Oxide form: eg.  $\text{CaO}$  (unslaked, burned, quick lime)
- ii.** Carbonate form: eg. Calcite ( $\text{CaCO}_3$ ), dolomite  $\text{CaMg}(\text{CO}_3)_2$
- iii.** Hydroxide form: eg.  $\text{Ca}(\text{OH})_2$  (slaked, hydrated lime)

## Oxide form: eg. CaO

- \* Commercial oxide of lime is normally referred to as unslaked (no water molecule) lime, or burned lime or quick lime.
- \* It is the white powder & more expensive than other limes.
- \* It is produced by heating calcite (CaCO<sub>3</sub>) or dolomite in oven or furnace in which the following reaction takes place :



- \* It has caustic properties; reacts much rapidly with soil.
- \* Thorough/well mixing with soil is necessary otherwise there will be caking problem (difficult to handle).
- \* It is much more effective among all liming materials, NV is 178% as compare to pure CaCO<sub>3</sub>

## ii. Carbonate forms eg Calcite & dolomite

- The 2 important minerals included in **limestone** are **Calcite** ( $\text{CaCO}_3$ ) & **Dolomite** ( $\text{Ca.Mg.}(\text{CO}_3)_2$ );
- When there is little or no-dolomite, it is referred to as **calcite**. As the Mg increases, it is referred to as **dolomitic limestone**.
- Dolomite has **NV 75 to 99%** while the representative crushed limestone is about **94%**.

## li. Hydroxide form

- Hydroxide form of lime is commonly referred as **hydrated lime** or **slaked lime**, since adding water to burned lime produces it.



- $\text{Ca}(\text{OH})_2$  has **NV 135%**.

## Describe how liming materials increase soil pH

- Limestone contain  $\text{CaCO}_3$  &  $\text{MgCO}_3$
- The limestone **dissolves in water** to form **carbonic acid &** calcium hydroxide:  $\text{CaCO}_3 + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3 + \text{Ca}(\text{OH})_2$
- Carbonic acid is **unstable** and converts to carbon dioxide ( $\text{CO}_2$ ) and water; the  $\text{CO}_2$  gas escapes:  $\text{H}_2\text{CO}_3 \leftrightarrow \text{CO}_2 + \text{H}_2\text{O}$
- Calcium hydroxide dissociates:  $\text{Ca}(\text{OH})_2 \leftrightarrow \text{Ca}^{2+} + 2\text{OH}^-$
- The  $\text{Ca}^{2+}$  replaces  $2\text{H}^+$  from the soil, increasing the soil BS
- The **hydroxide anion ( $\text{OH}^-$ )** reacts with the soil **acid cation ( $\text{H}^+$ )**, forming water:  $\text{OH}^- + \text{H}^+ \leftrightarrow \text{H}_2\text{O}$

# Factors affecting the liming

## 1. Amount:

- Crops differ in sensitivity to soil and added lime in soil.
- Amount of lime to be applied depends on inherent properties of soil i.e. texture, clay type and OM content.
- In a coarse textured with low OM soil, the lime requirement will be less than for a fine textured, high OM soils.

## 2. Timing:

- Liming reacts slowly with soil acidity.
- Lime may not have adequate time to react with soil if applied just before seeding.
- Due to its gradual effect, lime should be spread about 6-12 Months ahead of crop that has the highest pH and Ca requirement.
- For rotations that include leguminous crops, lime should be applied 3-6 months before the seeding time.



### 3. Frequency:

- \*The lime requirement depends on soil texture, N source and rate, crop removal, precipitation patterns and lime rate.
- \*On sandy soils, frequent light applications are preferable whereas on fine textured soils, large amounts may be applied less frequently.
- \*For humid regions, where the forces of acidification proceed excessively, application to arable soils is not done once but must be repeated every 3-5 years.

## Soil salinity

- The condition of soil where there will be the higher concentration of dissolved/soluble salts(ions) that is sufficient to interfere the growth of most plants is known as soil salinity.
- Salts present are typically dominated by carbonate ( $\text{HCO}_3^-/\text{CO}_3^-$ ), sulfate ( $\text{SO}_4^{2-}$ ) & chloride ( $\text{Cl}^-$ ) of Ca, Mg, Na, K
- In general, NaCl is the most abundant.
- The salinity is measure primarily by measuring the Total Dissolved Solids (TDS) and Electrical Conductivity (EC).

**THANK YOU**