Interrelationship of nutrient availability and soil pH

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Introduction:

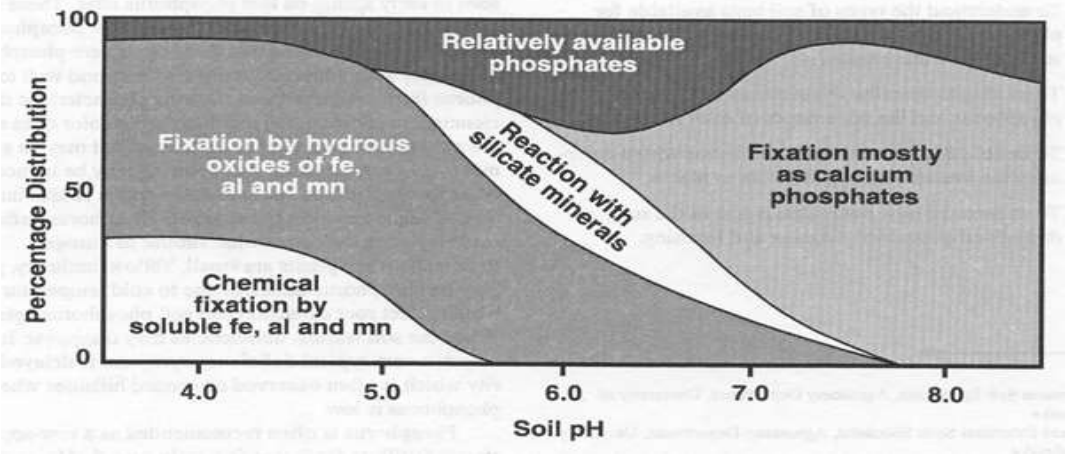
Soil pH: pH is defined as the negative logarithum of hydrogen ions activity of soil or soil reaction is an indication of acidity and alkalinity of soil and is measured in pH units. The pH scale goes from 0-14 with pH 7 as the neutral point. As the amount of H ions in the soil increase the soil pH decrease thus become more acidic. From 7 to 0 the soil is increasing more acidic and from pH 7-14 the soil is increase more alkaline and base.

Nitrogen availability in relation to pH

- Nitrate uptake is favored by low pH conditions.
- NH_4 uptake is proceeds best at neutral pH values and is depressed by increasing acidity.
- The range of reaction over which nitrification takes place has generally been given as pH 5.5 to about 10 with the optimum around pH 8-5.

Phosphorus availability in relation to pH

- $H_2PO_4^-$ uptake is favoured by acidic condition
- HPO_4^{2-} uptake is favoured by neutral to slightly alkaline conditions
- PO_4^{3-} uptake is favoured by strongly alkaline condition



- Availability of phosphorus is high within pH range of 6.7 to 7.5 due to higher solubility of phosphorus compound. At low pH phosphorus is precipitated as Fe and al phosphate while at high pH calcium phosphate is formed which is less soluble.

Potassium availability in relation to pH:-

- At lower pH, H^+ ions replace K and leaching of K occurs. At high pH potassium compounds are converted into non-exchangeable form and thus availability is reduced.
- Potassium fixation capacity can be reduced by the presence of Al^{+3} and aluminum hydroxide cations.
- In very acid soils toxic amounts of exchangeable aluminum & manganese create an unfavourable root environment for the uptake of potassium.

Influence of pH and nutrient availability:-

- pH influence rate of nutrient release through its influence on decomposition, cation exchange capacity and solubility of materials.
- The important source of nitrogen and sulphur is organic matter. Decomposition of organic matter is slowest at pH below 6 & fastest between 6 and 8.
- Availability of Fe, Al, Mn, Ca, and Zn are influence by pH through its effect on solubility of their

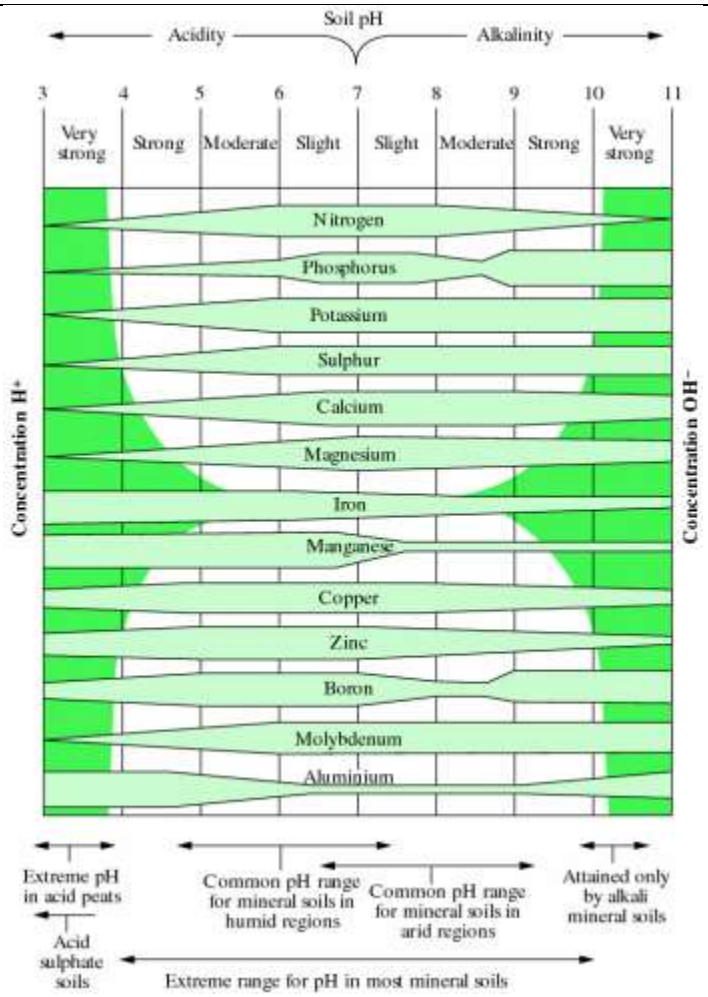
nutrient compounds.

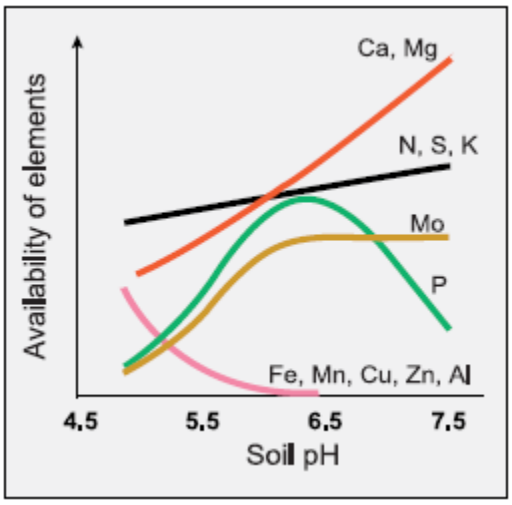
- Metalic cations such as Fe, Mn, Cu, Zn and also B precipitate at high pH hence their availability is less in alkaline soils.
- The availability of K & B is influenced by pH through its effect on cation exchange capacity.
- Sulfur – oxidizing organisms appear to have different pH requirement, but in general oxidation of added sulfur proceed most rapidly under acidic soil condition.
- Soil pH in the nearly neutral range is normally expected to encourage microbial activity, including sulfur mineralization.
- High H^+ activity occurring at low soil pH will impede calcium uptake. In acid mineral soils calcium is not readily availability to plants at low base saturation.
- The availability of calcium and magnesium are found pH 7 to 8.5.
- Iron deficiency occurs in calcareous and high pH soil in arid region. The available and exchangeable iron decrease with increase in pH as it is inversely related to solubility of iron.
- Availability of manganese increase in acid soil as in case of iron. In acid soils the available manganese is up to 16% of total manganese content of soils, while in alkaline soils it solder exceeds 1%.
- The mobility of copper in soil solution often decreases with increasing pH.
- Zinc is usually more available to plants in acid soils than in alkaline soils. Most pH induces zinc deficiency occur within the range 6 to 8 and calcareous soils are particularly prove to nutritional problems. At high pH zinc forms insoluble compounds such as $Zn(OH)_2$ and $ZnCO_3$ leading to its availability.

- Zn availability is highly pH dependent decreasing 100 fold for each.
- Boron adsorption increase with pH. More than 72% of applied water soluble boron is converted into water insoluble at pH above 7.5. The availability of applied boron is therefore reduced in alkaline soils.
- The availability of molybdenum is high at high pH. MoO_4^{2-} is exchanged for two hydroxyl ions from the clay. Oxides of Fe and Al increase the adsorption of molybdenum.
- Higher levels of phosphorus fertilizers increase availability of molybdenum. But sulphur reduces.
- The great mobility of chlorine in all soils but extremely in acid to neutral range and becomes negligible at pH >7.

Optimum pH ranges for availability of different nutrients

Nutrient	**Optimum pH range**
N	6.0 – 8.0
P	6.5-7.5
K	6.0-7.5
S	6.0 and above
Ca and Mg	7.0-8.5
Fe	6.0 and below
Mn	5.0-6.5
Bo,Cu,Zn	5.0-7.0
Mo	7.0 and above


Soil pH
Acidity
Alkalinity
3
4
5
6
7
8
9
10
11
Very strong
Strong
Moderate
Slight
Slight
Moderate
Strong
Very strong
Nitrogen
Phosphorus
Potassium
Sulphur
Calcium
Magnesium
Iron
Manganese
Copper
Zinc
Boron
Molybdenum
Aluminium
Concentration H+
Concentration OH-
Extreme pH in acid peats
Acid sulphate soils
Common pH range for mineral soils in humid regions
Common pH range for mineral soils in arid regions
Attained only by alkali mineral soils
Extreme range for pH in most mineral soils


Availability of elements
Ca, Mg
N, S, K
Mo
P
Fe, Mn, Cu, Zn, Al
4.5
5.5
6.5
7.5
Soil pH

References (if any)
1. S.L. Tisdale, W.L. Nelson, J.D. Beaton and J.L. Havlin "Soil fertility and fertilizer". 2. Reddy and Reddy "Principle of Agronomy".

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