SOIL RELATED TOXICITIES IN RICE ECOSYSTEMS OF KERALA

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Soil Acidity

- Over 90 percent of the soils of the state are acidic
- Soil acidification caused by preferential leaching of bases, high rainfall, acidic nature of the parent material, organic matter decomposition and indiscriminate use of acid forming fertilizers.
- High rainfall and temperature conditions are conducive to intense weathering and leaching, leading to development of acidic conditions
- Soils of Kuttanad, Pokkali, Kole and Kaipad are adjoining the coast and some areas lie below the sea level.
- Often contain sulphide bearing minerals from marine sediments at different depths from surface.
- Sulphidic minerals like jarosite and marcasite on drying produce extreme acidity in soils by oxidation and hydrolysis.
- These soils are often referred to as potential acid sulphate soils.

- Submergence (reduced condition), prevent their oxidation and conversion to true acid sulphate soils which due to sulphur oxidation releases sulphuric acid causing extreme acidity and damage to crops
- The major problem is toxicity of iron and aluminum
- Ill drained conditions and poor internal and external drainage
- Deficiency of calcium and magnesium and decreased availability of phosphorus due to fixation
- Impaired microbial activity affects nitrogen fixation s
- Slowing down of organic matter decomposition.
- Extremely acid conditions affect soil bacteria and fungal activity thereby enhancing or inhibiting development of soil borne plant diseases

Salinity

- Salinity in Kerala occurs in areas bordering the coast caused by sea water intrusion.
- These areas are below the high tide level and have to be artificially protected
- Rice growing areas affected by salinity are the low lying coastal sandy areas of Onattukara parts of Kuttanad, Kole, Pokkali and Kaipad lands
- Severity of the salinity is closely related to the monsoon rains.
- Salt is easily washed away by the high precipitation, either by downward movement through the soil or by lateral surface drainage
- Salinity levels vary with the season
- Rice is a moderately tolerant crop to saline conditions and tolerance varies with the variety.
- Duration of the saline period and the concentration of the salts are important.
- Saline resistant varieties are popular in these areas
- Areas with marine salinity problems, the logical solutions are protection by dykes.
- In potential acid sulphate areas soils, permanent blocking of saline water can have deleterious effects on physico-chemical properties of soil

Iron Toxicity

- Iron toxicity may be suspected when a reddish or brown scum of Fe $(OH)_3$ is visible on the soil surface or along cracks, or when a thin oily-looking layer of Fe $(OH)_3$ floats on the inundation water
- Often observed in ill-drained areas of Kuttanad and Kole lands and ribbon valley areas in the midland laterite region
- Under submergence anaerobic microorganisms initiate the reduction of soil components with a high oxidation state such as MnO_2 and NO_3^-
- Once these are depleted, insoluble Fe_3^+ compounds often present in the form of Fe $(OH)_3$, are reduced to soluble Fe_2^+ compounds
- Reduction of iron shows gleyed subsoil and mottled horizons characterised by grey colours and reddish colours indicative of alternate oxidation and reduction
- Iron toxicity in rice plant may show purplish brown discoloration called "bronzing" or yellowish to orange discoloration.
- Growth and tillering are depressed and the root system is scanty, short, coarse, and stained brown or reddish colours
- Low levels of P, K, Ca , and Mg rather than high levels of active Fe induce Fe toxicity
- Pre flooding (to avoid the Fe peak), increasing the O_2 supply in the surface soil by cut-off drains in seepage areas,
- Fertilization (to restore nutrient balance) and liming reduces the effect of toxicity
- Desalinization (to increase the bicarbonate-total anion ratio) are possibilities to overcome toxicity

AluminumToxicity

- Occurs in parts of Kuttanad and Kole areas where potential acid sulfate soils occur and where the rise of pH is slower
- Also Occur in ill drained ribbon valley soils (Brown hydromorphic soils) of the midland laterite regions
- Toxic concentrations can occur only at pH values below 5.
- In most acid wetland soils, the pH rises well above 5 shortly after flooding so that Al toxicity is no problem
- Phosphorus deficiency is associated with Al toxicity because insoluble Al-phosphates are formed, causing P fixation
- Providing surface drainage and early rainy season promote the leaching of soluble salts from the surface soil.
- This practice is widely followed in areas under the influence of marine salinity alsoreduces the salinity

Hydrogen sulfide toxicity

- Occurs in parts of Kuttanad and Kole areas with potential acid sulfate soils which on reduction forms hydrogen sulphide
- Low concentrations of H_2S are observed due to formation of FeS which is insoluble and harmless to the plant
- On acid sulfate soils, liming to raise the pH above 5.2 in flooded conditions is recommended to alleviate toxicity

Reference

Ponnamperuma, F.N. (1972). The Chemistry of Submerged Soils, Reprinted from: Advances in Agronomy, Vol. 24, ©1972,Academic Press, Inc

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Thank You