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Agronomic Practices in Relation to Problematic Soils

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Agricultural scenario in India is rapidly changing in response to various stresses experienced by cultivated lands. Agriculture sector cannot wait and must respond to manage the change and to meet the growing and diversified needs in the production to consumption chain. Nearly 7.0 million ha of agricultural land is affected by varying degrees of salt problems in the country. The affected area is likely to increase in the near future due to secondary salinization in irrigation commands and lift irrigated schemes, increase in dependence of agriculture on poor quality waters in semi-arid and arid regions, sea water intrusion and brackish water aquaculture in coastal regions. By 2025 area projected under salt affected soils in India is about 13 million ha. Agronomists have been playing and will have to play a crucial role in managing such lands and enhance productivity through agronomic research, develop comprehensive understanding and better contingency plans based on resource efficient, socio-economically viable and environmentally safe technologies to deal with salt affected soils in changing climatic scenario. Various agronomic practices in relation to problematic soils are discussed below.

1.1 Slow Permeable Soils/Impermeable Soils and their Management

(i) Incorporation of organics: Addition of organics namely FYM/composted coir pith/press mud at 12.5 t ha-1 found to be optimum for the improvement of the physical properties

(ii) Formation of ridges and furrows: For rainfed crops, ridges are formed along the slopes for providing adequate aeration to the root zone.

(iii) Formation of broad beds: To reduce the amount of water retained in black clay soils during first 8 days of rainfall, broad beds of 3-9 m vide should be formed either along the slope or across the slope with drainage furrows in between broad beds.

(iv) Providing open/ subsurface drainage

(v) Huge quantity of sand /red soil application to change the texture

(vi) Contour /compartmental bunding to increase the infiltration

(vii) Application of soil conditioners like vermiculite to reduce runoff and erosion

1.2 Soil Surface Crusting

Remedial measures

When the soil is at optimum moisture regime, ploughing is to be done. Lime or gypsum @ 2 t ha^{-1} may be uniformly spread and another ploughing given for blending of amendment with the surface soil.

Farm yard manure or composted coir pith @ 12.5 t ha^{-1} or other organics may be applied to improve the physical properties of the soils Scraping the surface soil by tooth harrow will be useful. Bold grained seeds may be used for sowing on the crusted soils. More number of seeds/hills may be adopted for small seeded crops.

Sprinkling water at periodical intervals may be done wherever possible. Resistant crops like cowpea can be grown

1.3 Sub Soil Hard Pan

The sub soil hard pan is characterized by high bulk density (>1.8 Mg m^{-3}) which in turn lowers infiltration, water holding capacity, available water and movement of air and nutrients with concomitant effect on the yield of crops.

Chiselling technology to overcome the sub soil hard pan The field is to be ploughed with chisel plough, a tractor drawn heavy iron plough at 50 cm interval in both the directions. Chiselling helps to break the hard pan in the sub soil besides it ploughs up to 45 cm depth.

Farm yard manure or press mud or composted coir pith at 12.5 t ha-1 is to be spread evenly on the surface. The field should be ploughed with country plough twice for incorporating the added manures. The broken hard pan and incorporation of manures make the soil to conserve more moisture

1.4 Shallow Soils

- Occurrence and Causes: In Tamil Nadu, shallow soils occur over an area of around 1,16,509 ha. Shallow soils are formed due to the presence of parent rocks immediately below the soil surface (15-20 cm depth).
- Impact: The shallow soil restricts root elongation and spreading. Due to shallowness less volume of soil is available exhaustive soil nutrients.
- Management : Frequent renewal of soil fertility Growing shallow rooted crops. Growing crops that can withstand shallowness (Mango, country goose berry, fig, tamarind, ber and cashew etc)

1.5 Highly Permeable Soils

- Management technology

The soils should be ploughed uniformly. Twenty-four hours after a good rainfall or irrigation, the soil should be rolled 10 times with 400 kg stone roller of 1 m long or an empty tar drum filled with 400 kg sand at optimum moisture (13 %). Then shallow ploughing should be given and crops can be raised. Application of clay soil up to a level 100 t ha^{-1} based on the severity of the problem and availability of clay materials. Application of organic materials like farm yard manure, compost, press mud, sugar factory slurry, composted coir pith, sewage sludge etc. Providing asphalt sheet, polythene sheets etc. below the soil surface to reduce the infiltration rate. Crop rotation with green manure crops like Sun hemp, sesbania, daincha, kolinchi etc. Frequent irrigation with low quantity of water. Frequent split application of fertilizers and slow-release fertilizers like neem coated urea.

Salt - Affected Soil

2.1 Saline Soils: The reclamation of saline soils involves basically the removal of salts from the saline soil through the processes of leaching with water and drainage Provision of lateral and main drainage channels of 60 cm deep and 45 cm wide and leaching of salts could reclaim the soils. Sub-surface drainage is an effective tool for lowering the water table, removal of excess salts and prevention of secondary salinisation. of ions like chloride, sulphate,

Management of saline soils: The reclamation of saline soils involves basically the removal of salts from the saline soil through the processes of leaching with water and drainage. Provision of lateral and main drainage channels of 60 cm deep and 45 cm wide and leaching of salts could reclaim the soils. Sub-surface drainage is an effective tool for lowering the water table, removal of excess salts and prevention of secondary salinisation.

Irrigation management: Proportional mixing of good quality (if available) water with saline water and then using for irrigation reduces the effect of salinity. Alternate furrow irrigation favours growth of plant than flooding. Drip, sprinkler and pitcher irrigation have been found to be more efficient than the conventional flood irrigation method since relatively lesser amount of water is used under these improved methods.

Fertilizer management: Addition of extra dose of nitrogen to the tune of 20-25% of recommended level will compensate the low availability of N in these soils. Addition of organic manures like, FYM, compost, etc helps in reducing the ill effect of salinity due to release of organic acids produced during decomposition. Green manuring (Sunhemp, Daincha, Kolingi) and or green leaf manuring also counteracts the effects of salinity.

Crop choice / Crop management: Crops are to be chosen based on the soil salinity level. The relative salt tolerance of different crops is as follows: Relative tolerance of crops to salinity Threshold Plant Threshold Plant Species Salinity (dS m^{-1}) salinity (dS m^{-1}) species Field crops, Vegetables, Cotton.

Soil / cultural management: Planting the seed in the centre of the raised bed / ridge may affect the germination as it is the spot of greatest salt accumulation. A better salinity control can be achieved by using sloping beds with seeds planted on the sloping side just above the water line. Alternate furrow irrigation is advantageous as the salts can be displaced beyond the single seed row. Application of straw mulch had been found to curtail the evaporation from soil surface resulting in the reduced salt concentration in the root zone profile within 30 days.

2.2 Alkali / Sodic Soils

Physical Amelioration: This is not actually removing sodium from exchange complex but improve physical condition of soil through improvement in infiltration and aeration. The commonly followed physical methods include. Deep ploughing is adopted to break the hard pan developed at subsurface due to sodium and improving free-movement water. This also helps in improvement of aeration. Providing drainage is also practiced to improve aeration and to remove further accumulation of salts at root zone. Profile inversion – Inverting the soil benefits in improvement of physical condition of soil as that of deep ploughing. Sand filling which reduces heaviness of the soil and increases capillary movements of water.

Crop choice: Rice is preferred crop in alkali / sodic soil as it can grow under submergence, can tolerate fair extent of ESP and can influence several microbial processes in the soil. Agroforestry systems like silviculture, silvi pasture etc. can improve the physical and chemical properties of the soil along with additional return on long-term basis. Some grasses like *Cynodon dactylon* (Bermuda grass) etc. has been reported to produce 50% yield at ESP level above 30.

2.3 Saline-Alkali/ Sodic Soils: Management of saline alkali soils, the reclamation / management practices recommended for the reclamation of sodic soil can be followed for the management of saline – sodic soil

2.4 Acid Soil: Occurrence Acid soils occupy approximately 60% of the earth land area and are arise under humid climate conditions from carbonaceous less soil forming rocks in all thermal belts of the earth.

- World-wide – 800 M ha
- India - 100 M ha

- Management of acid soils: Management of the acid soils should be directed towards enhanced crop productivity either through addition of amendments to correct the soil abnormalities or by manipulating the agronomic practices depending upon the climatic and edaphic conditions.

Soil amelioration: Lime has been recognized as an effective soil ameliorant as it reduces Al, Fe and Mn toxicity and increases base saturation, P and Mo availability of acid soils. Liming also increases atmospheric N fixation as well as N mineralization in acid soils through enhanced microbial activity. However, economic feasibility of liming needs to be worked out before making any recommendation.

Liming material: Commercial limestone and dolomite limestone are the most widely used amendments. Carbonates, oxides and hydroxides of calcium and magnesium are referred to as agricultural lime. Among, the naturally occurring lime sources calcitic, dolomitic and stromato litic limestones are important carbonates.

The other liming sources are marl, oyster shells and several industrial wastes like steel mill slag, blast furnace slag, lime sludge from paper mills, press mud from sugar mills, cement wastes, precipitated calcium carbonate, etc equally effective as ground limestone and are also cheaper. Considering the efficiency of limestone as 100%, efficiencies of basic slag and dolomite are 110 and 94 % respectively.

Basic slag and pressmud are superior to calcium oxide or carbonates for amending the acid soils. Fly ash, a low- density amorphous ferro-alumino silicate, also improves pH and nutrient availability

Lime requirement of an acid soil may be defined as the amount of liming material that must be added to raise the pH to prescribed value. Shoemaker et al. (1961) buffer method is used for the determination of lime requirement of an acid soil

Crop choice: Selection of crops tolerant to acidity is an effective tool to counter this soil problem and breeding of such varieties is of specific importance for attaining higher productivity, particularly in areas where liming is not an economic proposition. The crops can be grouped on the basis of their performance in different soil pH range.

2.5 Acid Sulphate Soils: Management of Acid Sulphate Soils Management techniques are extremely variable and depend on many specific factors viz, the extent of acid formation, the thickness of the sulphide layer, possibilities of leaching or draining the land etc. The general approaches for reclamation are suggested bellow:

Keeping the area flooded. Maintaining the reduced (anaerobic). Soil inhibits acid development, the use of the area to rice growing. Unfortunately, droughts occur and can in short time periods cause acidification of these soils. The water used to flood the potential acid sulphate soils often develop acidity and injure crops. Controlling water table. If a non-acidifying layer covers the sulphuric horizon, drainage to keep only the sulphuric layer under water (anaerobic) is possible. Liming and leaching. Liming is the primary way to reclaim any type of acid soil. If these soils are leached during early years of acidification, lime requirements are lowered. Leaching, however, is difficult because of the high-water table commonly found in this type of soil and low permeability of the clay. Sea water is sometimes available for preliminary leaching.