Chapter - III

Management Practices for Crops Cultivation on Saline Soils
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Cultivation on Saline Soils

3.0 Establishing a good crop on saline soils is a challenging task. Unlike normal soils, the cultural practices for crop production in saline soils are different. Farmers can ensure a good crop and yield on saline soils by using following Management Practices.

3.1 Cultural Practices

Due to unfavorable soil environment, germination is adversely affected. Mortality of young seedlings and poor growth of the crops are common in saline soils. Higher seed rate with closer spacing is advisable to counter these effects. For cotton, pearl millet, sorghum, wheat, barley, mustard etc. about 25% higher seed rate over the recommended seed rate for normal soils ensures good crop stand. In case of transplanted crops, the number of seedlings per area should be increased.

Furrow planting may help in obtaining better crop stand and yield under saline conditions. Dargan and Chilarr (1973) observed that sowing of sugarbeet on one side of the ridge half way between top and bottom, opposite to the direction of the sun gave significantly higher yield than flat and ridge sowing. The salt concentration in the root zone under this method will be comparatively less due to more accumulation of salts in southern face of the ridge because of direct and intensive solar radiation on this side. Similarly, in case of sugarcane, trench method of planting gave significantly higher yield than flat sowing because of less concentration of salts in the root zone, which move to the top of adjoining ridges (Dargan et al., 1973).
Table 3.1
Recommended seed rate for different crops in saline soils

<table>
<thead>
<tr>
<th>Crop</th>
<th>Sowing time</th>
<th>Seed rate (kg/ha)</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>1st to 3rd week of Nov.</td>
<td>4th week of Nov. to 3rd week of Dec.</td>
<td>100</td>
</tr>
<tr>
<td>Barley</td>
<td>Middle of Oct. to mid of Nov.</td>
<td>Whole of Dec. to 1st week of Jan.</td>
<td>80</td>
</tr>
<tr>
<td>Mustard</td>
<td>1st to 3rd week of Oct.</td>
<td>4th week of Oct. to mid of Nov.</td>
<td>4</td>
</tr>
<tr>
<td>Cotton</td>
<td>1st week of April to mid May</td>
<td>Mid to end of May</td>
<td>12 (Desi Cotton)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 (American Cotton)</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>Last week of June to mid July</td>
<td>3rd week to end of July</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: Singh et al. (1992)

Seed-cum-fertilizer drill should be preferred to ensure uniform placement of seeds and fertilizer in lines at the optimum depth. Sowing with seed drills will give a uniform stand and lead to early emergence of seedlings. If seed drill is not available, sowing should be done by kera or pora method.

Chemical treatment of seeds improves salt tolerance of crops. On saline soil (pH 7.6, EC<sub>e</sub> 10.50 dS/m) highest yield of wheat crop was obtained when seeds were treated with 3 per cent Na<sub>2</sub>SO<sub>4</sub> solution when compared with control (Puntamkar et al., 1971). The other workers are in different opinion that grain yield of wheat and barley was not significantly affected when their seeds were pre-
soaked in salt solution. However, pre-soaking in low salinity tubewell water resulted in more grain yield than seeds pre-soaked in NaCl or Na₂SO₄ solutions.

Pre-soaking of seeds in variable concentration (mg/l) of GA, IAA, IBA and NAA, irrigated with saline water (EC 12 dS/m), have differential effect on plant height, root length, shoot production and grain yield. However, the hormones up to 200 mg/l induced significant changes in different growth attributes but affected adversely at 300 mg/l. The effect was more at higher levels. It seems to be that use of pre-soaked seeds either in salts or hormone solutions could be a beneficial cultural management practice. However, more work is needed to be done on this aspect (Gupta and Gupta, 1997).

3.2 **Soil Fertility Management**

Adverse effect of high salinity upto some extension on growth attributes can be checked by the application of balanced fertilizers. Many workers have observed positive interaction between salinity and added plant nutrient thereby resulting in high yield. Crop yield generally decreases with increasing salinity but for a given salinity level the yield can be increased by judicious use of fertilizers.

Saline soils are generally deficient in nitrogen. Availability of nitrogen to crops remains low in these soils mainly due to following reasons.

I] High leaching loss of NO₃⁻

II] Poor mineralization of organic nitrogen to inorganic forms due to high salinity and poor bacterial activity.

III] Poor symbiotic nitrogen fixation of atmospheric nitrogen due to adverse effect of salinity on rhizobia and legumes.
The nitrogen requirement of crops is higher in saline soils than in normal soils. Singh et al., (1992) have reported a significant increase in wheat yield up to 160 kg N/ha in saline soils. This level is nearly 20% higher compared to normal dose of nitrogen fertilizer for the same crop in non-saline soils. Under low to medium salinity, urea gives better results than ammonium sulphate. But at high salinity levels, it is preferable to use NH$_3$ containing fertilizers than fertilizers containing NH$_4^+$. Foliar application of nitrogen is much economical and beneficial in saline soils, because it saves irrigation which otherwise is required to dissolve and distribute the top dressed fertilizer effectively.

It has been observed by several workers that salinity adversely affects the conversion of NO$_3^-$, nitrogen into proteins thereby resulting in accumulation of inorganic nitrogen in plant parts. In certain parts of our country, the underground saline waters contain moderate amounts of NO$_3^-$, which sometimes become toxic to the plants. Continuous use of such waters delays maturity and adversely affects grain quality. In such areas, canal water should be used in combination with ground water to minimize the adverse effects.

Phosphatic fertilizers have beneficial effects on crop yield in saline soils, has been reported by many workers, even when soil contained high amounts of available phosphate. This is because of the fact that soil absorbs more phosphate at higher electrolyte concentrations (EC) than at lower EC. Thus in a saline soil phosphate will be available in solution for plant growth. In saline soils phosphate fertilization would enhance the yield by directly providing the phosphorous and by decreasing the uptake of toxic elements like Cl$^-$ and F$^-$. The yields of wheat and mustard increased significantly with the application of 30 kg/ha as compared to no application of phosphorous (Singh et al., 1990; 1992). Application of phosphorous
alongwith Farm Yard Manure (FYM) has been found beneficial because this combination avoid the salt injury symptoms in crops.

Saline soils generally have high available $K^+$ but in certain situations like excessive leaching, caused low $K^+$ status in the soil. Plant growth under high salinity levels generally proceeds with disturbed Na/K or Ca/K ratio and sometimes may show $K^+$ deficiency caused due to antagonistic effect of Na$^+$, Ca$^{2+}$ or Mg$^{2+}$. On moderately saline soils, application of potassic fertilizers may increase the crop yield either by directly supplying $K^+$ or by improving ionic balance in the uptake of Na$^+$, Ca$^{2+}$ and Mg$^{2+}$. Under high salinity conditions, it may be difficult to exclude Na from the plant by use of potassic fertilizers. Potassium (K$^+$) and chloride (Cl$^-$) ions are effective in osmotic adjustment by the leaves as both these ions are taken up very rapidly and can be accumulated in high concentrations in plants. For this reason, chloride salinity may be less detrimental than sulphate salinity. Saline soils in general are not deficient in micro nutrients. Organic manures may have additional advantages in saline soils because:

I. Green manures/FYM can serve as temporary binding agent for the ammonical pool of nitrogen and reduce its losses.

II. Addition of organic material would help reclamation process by reducing pH and exchangeable sodium in soils.

III. Because of small and less active microflora in saline soils, mineralization of organic nutrient are comparatively less.

It may, however, be noted that application of organic/green manures as a primary source of nutrients may fail to meet all the nutritional requirements of
crops. Hence mixture of both inorganic and organic manures in balanced proportion is recommended for maintaining higher yields and sustained production under saline conditions.

3.3 **Irrigation Water Management**

In saline soil, irrigation practices must take care of the osmotic stress which is created by the high amounts of salt present in the soil profile. Proper aeration to plant roots may be yet another factor which may modify the irrigation practices in saline environment. In the soils, salts often accumulate in the top few centimeters of the soil during non-crop periods. Under high water table conditions, duration between the two crops may cause excessive salt accumulation in the root zone. Under these conditions, both germination and yield of the crops are affected adversely. A heavy pre-sowing irrigation to leach down the accumulated salts is essential to improve germination and growth. The pre-sowing irrigation should be provided with good quality water.

In saline soils, evapotranspiration requirement of the crops is affected by the presence of soluble salts. As the amount of salts increases, the water available to the plants decreases. It is because the osmotic pressure of the soil solution increases with increase in the salt concentration and the plants are unable to extract water as easily as they can extract from normal soil. Light and frequent irrigations help in keeping the soil-water potential at a low level. The field-irrigation system must ensure the supply of water to the plants at the right time in appropriate quantity and quality at the place where the plants need it for optimum growth. However, depending on the availability of water and whether conditions, the irrigation requirements of different crops may change.
Selection of a suitable irrigation method is one of the important achievement for the management of crops on the saline soils. The irrigation methods are of three types, surface, subsurface and sprinklers. Drip method of irrigation is a recent development. It could be beneficially applied to saline conditions and helps in maintaining low salt concentration and higher moisture content in the soil resulting in favorable conditions for crop growth.

The time, frequently and quantity of irrigation water depend largely on water requirement of crops, climatic conditions, soil characteristics including texture, infiltration rate, moisture - tension relationship, irrigation methods, water quality and water table. Pandey and Sinha (1972) observed that many crops can be grown without irrigation if water table remains with in a specified depth provided ground water is of good quality.

3.4 Green Manuring

Green manuring is also one of the useful practices in the management of saline-water irrigated agriculture. Growing of a green manuring crop in reclaimed saline soils during summer is important because of the following reasons:

1. It provides a crop cover to the soil and therefore re-salinization of reclaimed soil is avoided. The irrigation water applied to crop also manages to keep the salt down.

2. The crop when turned over the soil, adds nutrients and organic matter which invariably helps to improve the crop yields.

Gupta (1983) reported that dhaincha (Sesbania aculeata) grows well and provides complete cover to the soil compared to sunnhemp which could not grow well in saline soils.
3.5 **Mulching**

Mulching as a means to control evaporation and salinity has been studied in great deal both in India and abroad. Mulches such as self-mulching organic mulching and plastic mulches have been used under experimental conditions. However, self mulching could be an effective tool in controlling salinity build-up in the root zone with minimum cost.

3.6 **Weeds, Diseases and Pest Control**

The incidence of weeds, diseases and pests in the crop grown in saline soils is not different than normal soils. Weed control and plant protection measures including use of weedicides, fungicides and antibiotics are practically the same as in a normal soil. Timely control and/or preventive measures to avoid weeds, diseases and pests will ensure good crop production in saline water.

3.7 **Alternate Management Technology**

Alternate technology for the management of saline soils include the art of growing salt tolerant grasses alone, afforestation or an appropriate combination of the two.

3.8 **Grasses for Saline Soils**

Selection of grasses for saline soils depends upon several factors such as climate, geographical conditions, the depth of water table, availability of irrigation water and quality of irrigation water. Grasses exhibit the highest degree of salt tolerance on saline lands. Perennial forage grasses growing close to ground level are ideal from the reclamation point of view because they do not only check
evaporation from the soil surface but also increase the organic matter content in the soil. Bermuda grass has been reported as tolerant grass to high salinity (Mass and Hoffman, 1977). Bernstein (1964) reported that Bermuda grass showed 10% yield reduction at ECe 13 dS/m and 50% at ECe 18 dS/m. Kumar and Gill (1993) while studying the effect of irrigation with highly saline water on different forage grasses in sand culture reported that grasses established the better when planted by rooted slips compared to when sown with seeds.

3.9 Aforestation of Saline Soils

In general, saline lands in India are more suitable for plantation of fuel than timber species. production of fuel from saline lands depends on the ability of tree species to withstand salinity, drought and various other adverse environmental conditions.

3.10 Planting Technique and Irrigation Management

For tree plantation on saline soils where ground waters are saline and water table remains very high, planting method should be such that the rain water is utilized to the maximum possible extent and the salt concentration level in the active root zone of young plants is kept at a minimum level to minimize the adverse effect of high salinity of soil and water.

Field studies carried out by Tomar and Gupta (1985) on seasonal variations in salinity and soil moisture due to the fluctuating water table indicated that subsurface planting of saplings (below 30 cm depth) would provide less hostile saline environment to the root. Sub-surface method is better than the ridge planting (Tomar and Gupta, 1984) because saplings planted on the ridges generally
remain in disadvantageous position resulting in their lower survival and reduced growth due to higher salinity.

3.11 **Agro-forestry for Saline Areas Near to Canals**

Salt tolerant trees may act as a "biological pumps" as they transpire large amounts of water. The companion halophyte shrubs/grasses could be used as ground cover and to check the upward flux of salts. Considering soil, agro-climatic and socio-economic factors, tree and companion crops can be chosen from the following:

Trees: *Eucalyptus, Casuarina, Tamarix, Populus, Prosopis, Leucaena, Acacia.*

Grasses: Kellar grass, salt grass, cord grass, Rhodes grass, Para grass.

Bushes: Salt bush, blue bush, Kochia.

About 200 meter wide belt of *Eucalyptus* Cord grass/Kellar grass on both sides of the canal could be grown to intercept seepage (Singh *et al.*, 1993).

3.12 **Highlights**

⇒ Selection of salt tolerant crops is one of the important step. The specific ion effect of an ion could be minimized by the selection of appropriate crop.

⇒ Deep ploughing, seed hardening and methods of crop planting like sloping ridge, raised bed to minimized the salt accumulation in the roots.

⇒ Liberal application of organic manures helps in minimizing the ill-effect of soil salinity on plant growth and development.
⇒ Consideration of “salt index” and “partial salt index” of fertilizers and choice of fertilizers carrying counter ions (ammonical forms under sulphate rich and nitrate form under chloride rich conditions).

⇒ Supplementing extra dose of nitrogen is useful in fertilizer management.

⇒ Increased number of irrigations and use of more water are the good ways to minimize the soil salinity.

⇒ Adequate knowledge of the various physical, mechanical and physico-chemical factors affecting particularly the moisture relationships of saline soils is quite necessary.

⇒ Cultural and agronomic practices suited for ameliorating saline soils.

⇒ Hydrological studies for ground water control.

⇒ Effective methods for leaching; drainage and lowering the water table must be used.

⇒ Crop rotations on saline soils are good in controlling the salinity.

⇒ Aforestation and pasture development.

⇒ Practices like sloping ridge, single and double row raised bed, alternate furrow irrigation, more water in every irrigation to ensure greater leaching of salts.

⇒ Drip and sprinkler irrigations to keep root absorption zone continuously moist and thereby lowering osmotic relation.

⇒ Self mulching as an effective tool in controlling salinity.

⇒ To avoid weeds, diseases and pests will ensure good crop production in saline soils.

⇒ Agro-forestry for saline areas.
3.13 The Aims and Objectives

The aim of the present investigation is to find out the effect of some growth regulators on various morphological, physiological and biological processes of turmeric under saline conditions with following objectives:

1. To find out the cheapest and promising plant growth regulator under varied salinity stress conditions for improving yield potential in turmeric.

2. To determine the physiological and biochemical characters as influence by growth regulators under saline conditions in turmeric.

3. To find out the traits of turmeric as affected by salinity of Sodium salts under the influence of growth regulators.

4. To increase the efficiency and productivity of turmeric crop under varied salinity stress conditions in response of growth regulators.