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Modern Techniques for Salt Stress Management in Fruit Crops

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Abstract: *Salinity is the saltiness or dissolved salt content (Such as Sodium Chloride, Magnesium and Calcium sulfates and bicarbonates) of a body of water or in Soil. Salt Stress is the osmotic forces exerted on plants when they are growing in a salt marsh or under other excessively saline conditions. Salinity remains one of men's oldest environment and horticultural problems and challenging to scientist for production and productivity in our country. Salinity is caused by various factors such as mineral weathering, use of faulty irrigation water, poor rainfall, high evaporation rates, etc. but canal irrigation has been held more responsible (Garg and Gupta, 1997). Around 10% of the world's total arable land is salt affected. Various soil reclamation methods like leaching, flooding, scrapping, green manuring, etc. are being used conventionally for mitigation of the malady. Ultramodern Magnetic technology (Grewal and Maheshwari, 2011) and skimming well technology (Rao, 2010) can be handy in manipulation of irrigation water which will not only improve soils physical properties but also will boost crop production.*

I. 1.Introduction

Any change in environmental conditions that might reduce or adversely change a plants growth or development" (Levitt, 1972). Plants which are unable to maintain steady growth and development because of various causes like freeze, chill, heat, drought, flood, salt, pest, pollution, etc. Saline means salt like mostly used for surface of soil covered with white salt efflorescence. Dissolved salt content Such as Sodium Chloride, Magnesium and Calcium sulfates and bicarbonates in the body of water or soil is the saltiness or salinity. Under excessively saline condition salt stress exerts osmotic forces on plants, its nothing but salt concentration high enough to lower the water potential. The process of increasing salt content is known as Salination. Salt stress is the oldest environmental and horticultural problem also, serves as a challenge to scientist as well as for the growers hampering production and productivity. Arid and semi-arid regions of the world are the areas which are prone to salinity problems. Marginal lands have high degree of natural salinity. Salt-affected soils may inhibit seed germination, retard plant growth and cause irrigation difficulties. Irrigated agriculture is being severely affected by salinity problems. Accumulation of salts in the soil is mainly due to faulty irrigation practices and improper drainage. Higher accumulation of the salt in soil is harmful for plant growth. Due to imbalanced mobility of salts in soil lead to development of problematic soil. Around 120 million tons of salt is added to soil from canal water and brackish underground water every year out of which only $1/5^{th}$ of the salts reaches its final destination i.e. sea. The soils with electrical conductivity of less than four dSm^{-1} are generally considered as salt-free, where almost all crops can be grown. With increased salt concentration choice of plants becomes narrow as tolerant species are preferred for particular environments. Salinity is measured in terms of electrical conductivity (dSm^{-1}). Lower salt concentration of soil lower the EC and lesser will be the effect on plants growth.

II. Factors Responsible

For development of saline soils several factors may be responsible some of them are listed below:

- Gradual withdrawal of ocean water and mineral weathering are chief factors responsible for salinization.
- Use of irrigation water also, faulty irrigation methods
- Poor soil drainage, In sufficient water supply and rise in ground water table
- More evaporation of water in arid/semi-arid region
- Canal irrigation has been held more responsible.(Garg and Gupta, 1997)

Approximately 10% of worlds 7000 Mha arable land surface consists of Saline or Sodic Soils of 1500 m ha of cultivated lands 23% are saline and another 37% are Sodic (F.A.O.). Saline soils normally occur in Punjab, Haryana, U.P., Gujarat, Rajasthan, West Bengal, Maharashtra, AP., Karnataka and Tamilnadu. These soils contain high pH, poor infiltration rate and poor permeability, poor physical condition which offer high mechanical impedance to the growth of roots. Highly accumulation of Na^+ salt causes the Sodic soil. Sodic soil found extensively in the states of Haryana, Punjab and Uttar Pradesh. (C.S.S.R.I., 2012)

III. Effects of Salt Stress on Different Fruit Crops

With increase in salt concentration above threshold level growth rate and size of plant progressively deceases. Stunted growth coupled with restricted lateral shoot development observed. Reduced leaves and fruit; decreased fresh and dry weight of plant parts also, observed. Generally leaves become thicker than normal. The top growth suppressed more than the root growth. Increased level of sodium salt affects plant nutritionally and ultimately physically. Losses in terms of yield are more in fruit crops as specific toxicity affect more than osmotic effect.

IV. Modern Methods

4.1.Skimming Well Technology: Skimming well is any technique employed with an intention to extract relatively freshwater from the upper zone of the fresh-saline aquifer. The skimming wells are low discharge (less than 28 l.p.s.) cluster of wells drawing groundwater from relatively shallow depth. Skimming wells are generally designed for irrigation (Saeed *et al*., 2002) or drinking water supply (Rao *et al.* 2006, 2007) purposes.

4.2.Need of Skimming Wells

- To get fresh water
- To manage root zone salinity
- To reduce energy requirement for low discharge

4.3.How to operate a skimming well?

- Well may be operated for the short period of time varying from 4-12 hrs, depending upon thickness of freshwater and recharging sources.
- Pumping rate of water is to be critically decided as proper pumping
- Rates of pumping of saline groundwater is a crucial decision variable, especially when sustained pumping have to be done on a long term basis.
- Unregulated pumping often results in up-coning phenomena resulting in increased salinity of pumped groundwater.

4.4. The types of skimming wells:

- Conventional single strainer well
- Multi-strainers wells
- Scavenger wells
- Radial collector wells
- Dug wells

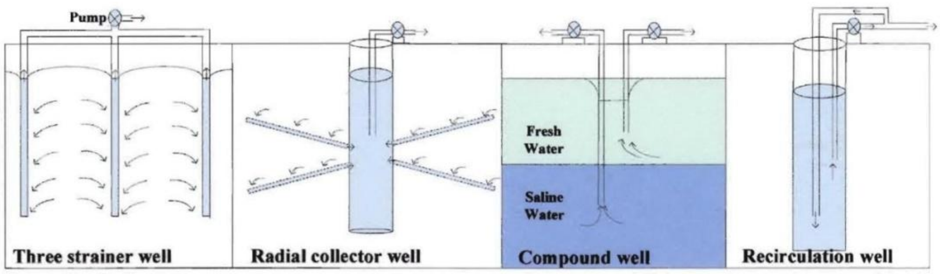

Figure 1: Layout of different designs of skimming wells systems

(Akbar, 2013)

4.4.1. Single Strainer Well:

A single strainer well can also be a skimming well if the gap between the lower end of the well and the fresh and saline water interface is sufficient to control the up-coning of saline water.

4.4.2. Multi Strainer Well: A multi-strainer well is capable of extracting 25 to 30 per cent more discharge than a single well under the same aquifer conditions.

4.4.3. Radial Collector: A radial collector well can exploit a thin layer of fresh groundwater through radial collector drains which carry the freshwater horizontally from aquifer to the well.

4.4.4. Scavenger Well: A compound or scavenger well comprises two wells located side by side. One well discharges water from the freshwater zone while the second operates at deeper depths and discharges saline water to control its up-coning. However, this well type has saline effluent disposal as well as environmental hazards.

4.4.5. Recirculation Well: A recirculation well works on the principle of injecting freshwater over saline water to control saline water encroachment. However, this technique, common in the petroleum industry, is new to the water industry. (Akbar, 2013)

V. How to install a skimming well?

- During drilling, take water samples at 3 intervals and measure electric conductivity (EC) of water
- At a depth, when EC of water sample is around 3 dS/m, stop further drilling. This depth may be assumed as fresh-saline water interface.
- Install well 40% penetration ratio. For example if water table is at 10 m depth and fresh-saline water interface is at 35 m, then water available for pumping is about 25 m. Therefore, skimming well may be installed at about 20 m from the soil surface
- Select number of strainers based on the freshwater available. Greater the freshwater thickness, lesser will be the number of strainers required
- The radial distance of strainers from pump should be less than 3 m
- Two skimming wells with a discharge of 28 lps (1 cusecs) should not be installed within a distance of 350 m from each other

VI. Benefits

- Improved quality of pumping groundwater
- Availability of locally manufactured material
- Availability of local expertise for drilling, installation and maintenance
- Shallow water table which helps in use of centrifugal pump units
- Technically simple systems
- Economically viable
- Improves soil health and crop yields

VII. Doruvu Technology:

A dug out conical pits locally called *Doruvu* in Andhra Pradesh and Kottai in Tamil Nadu, is used to skim fresh water floating on the saline water. Each *Doruvu* occupy an area of about 200 m^2.The water collected from each *Doruvu* is just sufficient to irrigate 800 m^2 . As such 10-12 *Doruvu* are needed for 1 ha area. An alternative to traditional *Doruvu,* AICRP center at Bapatla developed a popularly known Improved *Doruvu* Technology. In this set up , flow of water 1.8-2.0 m below the ground surface in collectors embedded is collected in a sump. This water is pumped and used to irrigate crops using sprinklers/drip.

VIII. Bio-drainage:

Tree species such as *Eucalyptus* Spp., *A. nilotica, D. sissoo* and *C. equisetifolia* are quite efficient in intercepting the canal seepage. Planting of 2-4 rows of these trees, 5 m away from the canal could intercept more than 80 % of the seepage and relieve water logging problem along the canals. (CSSRI)

IX. Magnetized water:

Water molecule usually travels in a cluster of different sizes depending upon the number of water molecules involved. Water molecule clusters are composed of water molecules that are loosely attached. Chaotic and loose formation permits entry of toxins and pollutant in the water molecule cluster. When these polluted water molecule clusters pass through the cell membrane many of the clusters which are larger in size due to higher toxin content becomes impermeable. Small sized clusters enter the cell with toxins. It requires a great deal of unstructured water to hydrate a plant. When magnetic field is applied to normal water it restructures water molecule into smaller molecule clusters each made up of six symmetrically arranged molecules. These are so called "bio-friendly" cell clusters due its hexagonal shape. As toxins cannot travel in clusters so, water easily hydrates plant cells. This provides maximum hydration in less water. (Maheshwari and Grewal, 2013)

X. Benefits

- Magnetic field further breaks down minerals into smaller particles making them more bio-available to the plant cells.
- Maximum hydration of healthy water with greater uptake of minerals results in greater yields, larger and better end product.
- It allows a reduction of amount of water needed, fertilizer and pesticides.
- Since the magnetic structuring breaks all minerals into smaller particles, salt in the soil is broken down by the structured water, causing it to sink deep into the soil, away from plant roots and wash away.
- The desalinization happens quickly over a season, creating much healthier plants, greater yields and better final product.

XI. Effect on Plants:

- High quality, bigger fruit; fewer inferior grade fruit.
- Quantity of fruits.
- Time for collecting the harvest.
- Difference in quantity and quality of harvest.
- All plants developed improved stress resistance.
- Percentage of crops standing.
- Development of root system.
- Speed of filtration.
- Magnetic water dissolves salts effectively.
- Magnetic water removes nitrate sulphates from the soil.

XII. Expenses

- Expenses that occur during the installment of magnetic systems for 1 hectare of land come up to approximately Rs. 50000.
- Magnetic devices do not need technical maintenance and do not require electrical energy.
- Life of devices is minimum 25 years.

XIII. Conclusion

There are immense possibilities to explore as very scanty research has done in fruit crops struggling with salinity problem. For mitigation of the salinity threat conventional technologies should be coupled with modern advanced methods which will prove a handy tool in mitigation of the malady. Use of ultramodern magnetic water technology will prove boon to farmers.

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