REVIEW ARTICLE

Management of arid fruit crops in saline environment: A review

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Salinity is the degree of saltiness or the amount of dissolved salt in a body of water or in soil, such as calcium, magnesium and sodium sulfates and bicarbonates salt. The osmotic forces that plants experience when growing in salt marshes or other extremely saline environments are known as stress. One of the oldest environmental and horticultural issues that humans have faced is salinity, which scientists find difficult to address in terms of output and productivity in our nation. Numerous causes contribute to salinity, including high evaporation rates, inadequate rainfall, mineral weathering and improper irrigation water utilization, but canal irrigation has been attributed with the greatest blame. The salt problem affects about 10% of all arable land worldwide. Conventionally, a variety of soil reclamation techniques, including leaching, flooding, scraping, green manuring, etc. are employed to lessen the disease. Due to soil salinity, crop yields have decreased by up to 50% and as a result, many places have stopped farming. Depending on the issue, extra soluble salts may be eliminated by subterranean drainage, flushing and leaching or scraping the salt crust on the surface. The capacity of crops to withstand salinity at different growth stages varies as well. The germination and early stages of most crops that get saline irrigations are often the most susceptible and as the crop ages, so does its tolerance. Important solutions for crop production in saline soils include salt-tolerant cultivars and other methods of managing arid fruit crops on saline soils.

Key Words: *Soil salinity; Manuring; Arid fruit; Irrigation water, Environment*

INTRODUCTION

Sodic or saline soils make up around 10% of the 7000 Mha of arable land on Earth of the 1500 hectares of arable land, 23% are salty and the remaining 37% are sodic. These soils have high pH, low permeability, low infiltration rate and poor physical condition, all of which contribute to the plant's steady decline in growth and limited ability to produce lateral shoots [1,2]. There were also fewer leaves and fruits, as well as a decrease in the fresh and dry weight of the plant parts. Generally speaking, leaves get thicker than usual. More repressed than the root growth was the top growth. Plants are impacted nutritionally and ultimately physiologically by elevated sodium salt levels. Produce losses are greater in fruit crops. Sodic soil found extensively in the states of Haryana, Punjab and Uttar Pradesh [3].

The main issues in the country's dry and semi-arid regions are salinity and sodicity. Approximately 7 million hectares of salt-affected soils exist in India, with a significant portion of these being in Rajasthan. In dry and semi-arid regions of India, ground water is the most important source of supplemental irrigation; yet, a sizable portion of them in north India are brackish or salty (Uttar Pradesh, 43%, Haryana, 55%, Rajasthan, 68%). In coastal regions, western Uttar Pradesh, Haryana, Punjab, Rajasthan, Gujarat and other places, saline soils are common. The problem of soil salinization and sodification has been caused by their careless and careless use, which disregards their salt concentration and composition in relation to soil type, crop, climate and management practices [4-6]. This has affected crop yields and made the general public doubtful of their usefulness as an additional source of irrigation. Thankfully, research into the management of salt-affected soils and saline water has advanced, demonstrating that the majority of waste land and saline water can be used productively as long as the fundamentals of soil-water-plant relationships are correctly understood and applied sparingly [7]. A sizable portion of Rajasthan has been affected by the issue of salt infestation brought on by the usage of saline fluids for irrigation. For development of saline soils several factors are 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.

In view of the high population pressure, the country has to put more area for production of cereals, pulses, oil seeds, etc. hence it is rather difficult to get good piece of fertile land for fruit cultivation. Under such circumstances, proper utilization of the salt affected soils offers a unique opportunity of bringing additional area under fruits for improving the ecosystem and national economy of the country. Fruits have special significance to human beings as a protective nutritional food. The yield and income per unit area are much higher as compared with cereals and many forest trees [8,9].

LITERATURE REVIEW

Quality of irrigation water

In order to manage irrigation effectively, information regarding the quality of irrigation water should be obtained prior to planting any fruit crops. Depending on the level of restrictions, irrigation waters can be generically classified as either good or saline alkali fluids. Two classes of low quality water have been further divided into three homogeneous subgroups each. (Table 1).

TABLE 1

Classification of different types of poor quality waters

Water quality	EC (dSm-1)	SAR $(mmol/l)^{1/2}$	RSC (meL-1)
A. Good waters	<2	<10	<2.5
B. Saline waters	-	-	-
(i) Marginally saline	2-4	<10	<2.5
(ii) Saline	>4	<10	<2.5
(iii) High Sodium Adsorption Ratio (SAR) saline	>4	>10	<2.5
C. Alkali waters	-	-	-
(i) Marginally alkali	<4	<10	2.5-4.0
(ii) Alkali	<4	<10	>4.0
(iii) Highly alkali	<4	>10	>4.0

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The limits which were fixed only for total salt concentrations are also given in Table 2.

Figure 1 provides the threshold values for crops expressed in terms of Electrical Conductivity of the saturation extract (ECe). The majority of the data came from crops that were cultivated in environments that mimicked advised cultural and managerial techniques for industrial production. As a result, the data show the relative tolerances of various crops grown in various environments. Moreover, the information is only applicable in situations when crops are grown from late seedling stages to maturity in relatively regular salinities. To use Figure 1, read the value of the soil salinity on the horizontal axis and follow it upward until it intersects the upper right hand line of the salt tolerance class for the crop that interests you. Then draw a line horizontally left to intersect the vertical 'relative yield' axis and read the number. This would be the percent yield obtainable with these salt conditions [10].

Selection of hardy fruit crops

Fruit cultivars have a complex salt tolerance due to additional negative effects brought on by certain ion toxicities. A poisonous buildup of Cl^- and/or Na^+ in the leaves can induce foliar damage in many perennial woody species. Within a single species, there may be significant diversity in tolerance due to the varying rates at which different cultivars and rootstocks absorb Cl^- and Na^+. Fruit crop's tolerance, like that of herbaceous crops, can be stated as a function of the soil solution's osmotic potential or total soluble salt concentration in the absence of specific-ion effects. Successful cultivation in salt affected soils, requires choice of hardy fruit plants which are adoptive to salt stress situations. Based on salt tolerance limit, the fruit crops have been classified into four groups.

a) High tolerance (40-50 ESP, 12-15 ECe): Date palm, ber, tamarind, lasora and wood apple.

b) Medium tolerance (30-40 ESP, 9-12 ECe): Phalsa, jamun, pomegranate, mulberry, karonda, annonas.

c) Low tolerance (20-30 ESP, 6-9 ECe): Guava, bael, grape.

d) Susceptible (<20 ESP, <6 ECe): Banana, papaya, pine apple, temperate fruits.

Within the safe bounds of their salt tolerance, these crops can be produced without the need for soil additives or the leaching of soluble salts. Without specific-ion toxicities, it is thought that the salt tolerance data in Table 3 are fairly reliable. Many crops have tolerances defined mainly for vegetative development because it is expensive and time-consuming to generate fruit yields [11]. Generally speaking, even in the absence of specific-ion effects, woody fruit and nut crops are more vulnerable to salt than other crop categories. Salt tolerance is only somewhat present in date palm [12,13].

Selection and popularization of tolerant cultivars

Efforts have been undertaken to investigate the genetic differences associated with salt tolerance in a few chosen fruit crops; the results of these efforts are listed in Table 4 below.

TABLE 2

Guidelines are using for saline water in India

Soil texture	Crop tolerance	ECiw (dSm-1) limits for rainfall regions		
		<350	350-550	>550
Fine	Sensitive	1.0	1.0	1.5
	Semi tolerant	1.5	2.0	3.0
	Tolerant	2.0	3.0	4.5
Moderately fine	Sensitive	1.5	2.0	2.5
	Semi tolerant	2.0	3.0	4.5
	Tolerant	4.0	6.0	8.0
Moderately coarse	Sensitive	2.0	4.0	6.0
	Semi tolerant	4.0	6.0	8.0
	Tolerant	6.0	8.0	10.0
Coarse	Sensitive	-	3.0	3.0
	Semi tolerant	6.5	7.0	9.0
	Tolerant	8.0	10.0	12.5

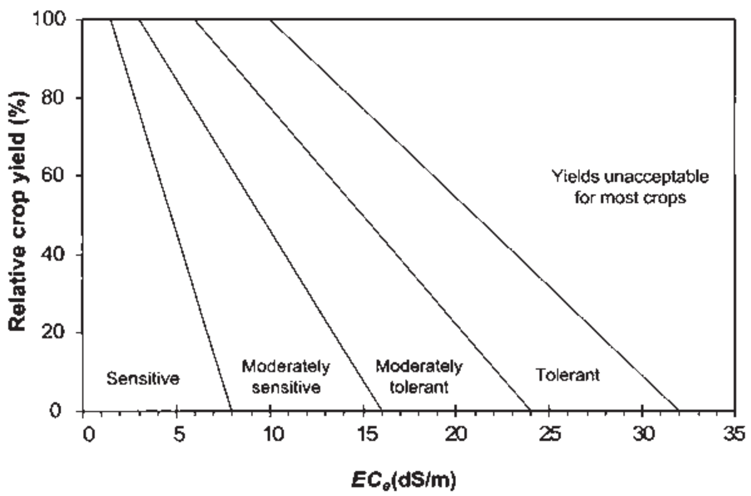

Figure 1) *Division for classifying of crop tolerance to salt salinity*

TABLE 3

Salt tolerance of different fruit crops

Common name	Botanical name‡	Tolerance based on	Threshold§ (ECe) dS/m	Rating¶	References
Date-palm	*Phoenix dactylifera*	Fruit yield	4.0	T	Furr & Ream [1]
Fig	*Ficus carica*	Plant DW	-	MT	Patil & Patil [2]
Grape	*Vitis vinifera*	Shoot growth	1.5	MS	Nauriyal & Gupta [3]
Guava	*Psidium guajava*	Shoot and root growth	4.7	MT	Patil & Patil [4]
Jamun	*Syzygium cumini*	Shoot growth	-	MT	Patil & Patil [5]
Jujube Indian	*Ziziphus mauritiana*	Fruit yield	-	MT	Hooda et al. [6]
Lemon	*Citrus limon*	Fruit yield	1.5	S	Cerda et al. [7]
Lime	*Citrus aurantiifolia*	-	-	S	-
Mandarin orange	*Citrus reticulata*	Shoot growth	-	S	Minessy et al. [8]
Natal plum	*Carissa grandiflora*	Shoot growth	-	T	Bernstein et al. [9]
Orange	*Citrus sinensis*	Fruit yield	1.3	S	Dasberg et al. [10]
Pomegranate	*Punica granatum*	Shoot growth	-	MS	Patil & Patil [11]

TABLE 4

Salt tolerance of different cultivars of different fruit crops

Fruit crops	Cultivar	ESP	ECe
Aonla	Seedling	43.5	9.7
-	Chakaiya	35	9
-	Kanchan	35	10.0
Bael	NB-5	30	-
Ber	Banarasi karaka	45	15.0
Guava	-	30	8.0
Grape	-	30	-
Jamun	-	35	-
Pomegranate	Jalore seedless	25.5	6.0
Phalsa	-	30	-

DISCUSSION

Utilization of tolerant/resistant rootstocks

Few of the fruit plants are susceptible to sodic/saline soil conditions with use of the tolerant/resistant rootstocks, their cultivation is possible to a great extent. Root stock must have capacity of reduced absorption of harmful salts *viz* $Na^{+}Cl^{-}$ and SO_4 ions from the soil solution. Higher proline content provides tolerance against moisture and salt stress. Therefore, rootstock should have higher proline content in the plant system so that these could tolerate harmful influence of the salts. Few of the tolerant rootstocks are as under

Mango: Naleshwar dwarf, kurrukan

Citrus: Cleoptra mandarin, rangpur lime

Grape: Dogridge, salt creek, 1613, 1616

Standardization of agro-techniques

Pit preparation: Cultivation in highly saline/sodic soils require leaching of soluble salts and incorporation of soil amendments as per Gypsum Requirement (GR) values. Care should be taken in pit preparation. The size of pits depends upon the type of soil and plants (Table 5). Sodic soils which are characterize by the presence of indurate clay and kankar pan, breaking the hard layer is essential before filling of pits. Pits should be dug in May-June and rains water should be allowed to collect in the pits. This collected dirty contains lot of soluble salts which must be thrown outside. After 2-3 washings, the pit should be filled as mentioned below. Incorporation of press mud or replacement of the salt affected soil of pits with pond soil have also been found very much effective in better establishment of fruit plants.

TABLE 5

Relative tolerance of different cultivars of different fruit crops

Fruit crop	Tolerant cultivars	Less tolerant cultivars
Aonla	Chakaiya, Kanchan, Francis	Banarasi, Krishna
Ber	Banarasi Karaka, Kaithali	Gola, Umran
Grape	Beauty seedless	Kishmishni, Charni
Guava	Sardar (L-49)	Allahabad safeda

In situ budding/grafting

It has been observed that seedling plants are much tolerant to salt affected soil as compared to cultivars. Therefore, it will be advisable to grow the seedlings in polybags/tubes or other suitable container, transplant them as per layout and these may be grafted after two or three years of their establishment.

Top working of seedling type

Seedling plants of ber are very common in salt affected regions particularly in the states of Rajasthan, Gujarat and Haryana. Sporadic plants of aonla, bael can also be noticed. Since these plants have already adapted to adverse soil conditions but have poor production and are often poor in quality. The conversion of such plants by top working/frame working will provide a unique opportunity for their better utilization of the land.

Intercropping

Most of the perennial fruit plants have long gestation period. In order to ensure some income and also reduce the moisture evaporation, it has been observed that suitable cropping models should be encouraged instead of monoculture. The following models have been also found suitable in sodic soil conditions:

- Aonla-ber-phalsa,
- Aonla-ber-karonda,
- Aonla-guava-phalsa,
- Aonla-guava-karonda.

Cultivation of above mentioned crops shall be helpful in assure income from 2nd and 3rd year of the orchard establishment, improving the organic matter content in the soil, keeping the weed population under control, reduce the evapotranspiration, improving the soil fertility growth and productivity of the crop. Growing and turning of green manure is also helpful in improving the soil conditions.

Continuous mulching with organic waste materials are helpful in improving the organic matter thereby improving the soil fertility, keeping the weed population under control and encouraging plant vigour.

Increased frequency of irrigation

Because of low inherent organic matter, poor structure of soil, low infiltration rate, water holding capacity of such soils are very poor. Delayed irrigation will result in upper movement of salts; hence light irrigation at short intervals is advisable. Irrigation should be done with sweet water. Modern irrigation techniques *viz*; drip; sprinkler will also be beneficial as compared with conventional method.

Selection of fertilizers

The inherent nutrient and organic matter content of the soil is very poor; hence, every effort should be made to incorporate at least 1/3 of nutrient requirement through Farm Yard Manure (FYM) and rest through inorganic sources. Fertilizers having acidic reaction *viz*; ammonium sulphate, Calcium Ammonium Nitrate (CAN), sulphate of potash should be preferred. 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.

CONCLUSION

In conclusion, while the cultivation of arid fruit crops in saline environments presents challenges, innovative approaches and technologies can enable successful cultivation, offering opportunities for sustainable agriculture and food security in arid and saline-affected regions. Continued research and collaboration among scientists, farmers and policymakers are essential to further unlock the potential of arid fruit crops in saline environments. Additionally, growing arid fruit crops in salty environments can have a number of benefits, such as less competition for freshwater resources, the use of marginal lands unsuitable for traditional agriculture and the possibility of producing quality produce and food sustainably in areas with degraded soil and limited water supplies.

FUTURE PROSPECTS

The future prospects for arid fruit crops in saline environments hold significant promise, driven by several factors:

Precision agriculture technologies

The adoption of precision agriculture technologies, including soil sensors, drones and satellite imagery, can facilitate precise management of irrigation, fertilization and other inputs in saline environments. This targeted approach helps optimize resource use and minimize the negative impacts of salinity on crop growth.

Improved irrigation practices

Advancements in irrigation techniques such as drip irrigation, micro-irrigation and reclaimed water usage can help mitigate the effects of salinity on arid fruit crops. These practices ensure efficient water delivery to the root zone while minimizing salt accumulation in the soil.

Soil management strategies

Implementing soil management practices such as soil amendments, mulching and cover cropping can improve soil structure, fertility and salinity levels. Soil amendments like gypsum and organic matter can help leach excess salts from the root zone and enhance soil health.

Climate-resilient agriculture

Arid fruit crops grown in saline environments can contribute to climate-resilient agriculture by requiring less freshwater and thriving in marginal lands. These crops can play a vital role in sustainable food production in regions vulnerable to climate change and water scarcity.

Market demand and economic opportunities

With growing consumer interest in healthy and exotic fruits, there is an increasing demand for arid fruit crops such as dates, figs and pomegranates. Cultivating these crops in saline environments can open up new economic opportunities for farmers and contribute to rural development.

Policy support and investment

Supportive policies and investments in research, infrastructure and technology are essential for realizing the full potential of arid fruit crops in saline environments. Government initiatives promoting sustainable agriculture, water management and land rehabilitation can create an enabling environment for their cultivation.

Overall, the future prospects for arid fruit crops in saline environments are bright, with opportunities for innovation, sustainability and economic growth. By leveraging advancements in science, technology and policy, farmers can successfully cultivate these crops and contribute to food security and environmental resilience in arid regions.

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