



REVIEW PAPER  
SOIL SCIENCES

## SOIL SALINITY HINDERS PLANT GROWTH AND DEVELOPMENT AND ITS REMEDIATION - A REVIEW

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### ABSTRACT

Salinity is an agro-natural condition that limits plant growth and development. It is a severe problem of parched and semi-bone-dry areas of the world, likewise it diminishes farming creation. In plants, salt pressure can bring about osmotic pressure, particle harmfulness, and dietary irregularity, finishing in the creation of reactive oxygen species (ROS). Salinity stress reduces agricultural and crop productivity by reducing plant growth and limiting land utilization. Excessive salt limits crop yield, and play role in removal of vegetation cover. Also, saline stress decreased the photosynthesis effect in plants. Due to industrialization or habitat degradation, agricultural land is diminishing at an alarming rate as the global population grows at an alarming rate. As a result, to meet the food demand, salt-affected land must be utilized by proper management. Problems faced by plants under salt stress are discussed in this article. Salinity has a well-documented impact on wheat growth and yield. The current review focused on the effects of progressive salinity on agricultural land, wheat salt tolerance mechanisms, and the existence of genetic diversity in wheat and their use in salt tolerance breeding. Furthermore, this review focuses on the relationship between salinity and productivity in grain crops, as well as strategies for identifying genetic variation in cereal crops to improve salt tolerance. Future research directions that could be used directly to wheat breeding projects around the world to enhance wheat yield.

**KEYWORDS:** Na<sup>+</sup> accumulation; plant physiology; plant growth; remediation; salinity stress; types of salinity; salt toxicity; wheat; Pakistan



### INTRODUCTION

Salinity is one of the most important environmental issues affecting plant productivity in arid and semi-arid region (Ashraf, 2001). Salinity in water system and soil is quite possibly the most genuine abiotic constraints that hinder plant growth. Soil salinity affects almost 800 million hectares of agricultural land worldwide (Munns and Tester, 2008). An osmotic pressure of around 0.2 MPa is formed when the electric conductivity (EC) of a soil arrangement exceeds 4 dS m<sup>-1</sup> (corresponding to 40 mM NaCl), resulting in a significant loss in crop yields (Munns and Tester, 2008). Chlorosis and necrosis in plants are caused by ion poisoning, which is caused by a buildup of Na<sup>+</sup> in the plant's tissues, which interferes with various physiological processes (Munns, 2002). The toxicity

of salinity varies depending on weather conditions, light intensity, plant species, and soil conditions. Glycophytes or halophytes plants can grow in saline environments based on their ability. Glycophytes, the most common crop plants, are unable to thrive in high-salt environments; 100-200mK NaCl concentrations hinder or even block their growth, resulting in plant death (Munns & Termaat, 1986). This type of growth suppression can occur even in the short term. Salinity stress affects a variety of physiological and metabolic systems of plants, which might limit crop output depending on the degree and duration of the stress (James *et al.*, 2011). Plant growth is inhibited by soil salinity, which causes osmotic stress, that is accompanied through ion toxicity (Rahnama *et al.*, 2010). Salinity frequently referred to as hyperosmotic

stress because of the osmotic stress of high salt accumulation in soil and plants during the early stages of salinity stress, which causes damage in root system decreases water absorption capacity by increasing water loss from leaves. In the early stages of salt stress, osmotic pressure causes a variety of physiological changes, including interruption of membranes, supplement unevenness, obstructed ability to detoxify reactive oxygen species (ROS), differences in disease counteraction specialist synthetics, reduced photosynthetic activity, and a decrease in stomatal opening (Munns and Tester, 2008). The buildup of Na<sup>+</sup> and Cl<sup>-</sup> ions in tissues of plants exposed to soils with high NaCl concentrations is one of the most harmful impacts of salinity stress. Both Na<sup>+</sup> and Cl<sup>-</sup> enter the cells, causing a severe ion imbalance, and excessive absorption could lead to serious physiological problems (s). High Na<sup>+</sup> focuses forestall the take-up of K<sup>+</sup> particles, which is fundamental for development and improvement, bringing about diminished efficiency and even passing. In reaction to salt stress, the generation of reactive oxygen species (ROS) such as singlet oxygen, superoxide, hydroxyl radical, and hydrogen peroxide increases (Ahmad, 2010). The oxidative damage caused by ROS produced by salinity can disrupt important plant processes by causing oxidative damage to numerous cellular additives consisting of proteins, lipids, and DNA (Gupta and Huang, 2014). The main purpose to review soil salinity that affects plant growth and its remediation, from which technique we can overcome the salinity and also, we will review wheat growth affected by salinity and short discussion on salt tolerance of other cereals. The complete substance of salt and the proportion of Na<sup>+</sup> to Ca + Mg in the immersed concentrate of the soil were initially used to arrange soils as saline, sodic, or saline-sodic. The need for fresh water is increasing in diverse locations as a result of population expansion in the municipal, industrial, and agricultural sectors. As a result, agriculture's freshwater allocation has been reduced. The tendency is predicted to retain and deteriorate in much less advanced arid-area countries, which have already got excessive population growth rates and most important environmental problems. According to Carvajal *et al.* (1999). Salts have three different types of direct effects on plant growth: i) a decrease in the soil solution's osmotic potential, decreasing the amount of water available to the plants; (ii) an adjustment of the actual construction of the dirt, bringing about diminished water penetrability and soil air circulation; and (iii) an expansion in the centralization of explicit particles that obstruct plant digestion (explicit particle harmfulness and mineral supplement insufficiencies).

### Problem of soil salinization

Soil salinity is a major problem of agriculture. Saline soils are common in hot and arid regions of the world, and therefore have little agricultural potential. In these areas, the majority of plants are grown at below irrigation, and to make topics worse, insufficient irrigation control reasons secondary salinization, which influences 20% of irrigated land globally (Glick *et al.*, 2007). Irrigated agriculture is a major human activity in arid and semi-arid locations, and it frequently leads in secondary salinization of land and water supplies. When minerals in the dirt collide, particles are released. They can also be used as fertilizers or irrigated, and they can travel higher in the soil from shallow groundwater. When rainfall is insufficient to discharge ions from the soil profile, salts build in the soil, resulting in soil salinity (Blaylock, 1994). Salts that dissolve in water can be found in all dirt's. Fundamental supplements are consumed by plants as solvent salts, yet exorbitant gathering repress plant development. Physical, synthetic, or potentially natural soil corruption measures have had significant impacts for worldwide regular assets over the earlier century (for instance, compaction, inorganic/natural pollution, and diminished microbial action/variety). The area beneath the damaged soils continues to develop each year due to the introduction of irrigation in new regions (Patel & Dave, 2011).

Salinization is widely regarded as one of the most serious ecological and range from mild to severe in many nations, affecting more than 1 billion hectares area worldwide, or over 7% of the world's mainland area, or roughly multiple times the size of Venezuela or multiple times the size of France (Metternicht & Zinck, 2003). As indicated by dawn news, over 2.5 million hectares of watered land are influenced by serious surface saltiness, incorporating 18% in Sindh, 3% in Punjab, and 2% in the NWFP. Sindh has 10% decently beset regions, Punjab has 4% modestly affected regions, and the NWFP has 2% respectably affected regions. In Pakistan, it is estimated that around 7 million hectares are affected by soil salinity/solidity. The majority of this area is under canal control. Irrigated arable land faces a major threat of salinity. It's also been projected that one-third of the world's irrigated land is now salt-affected. Moreover, due to an excessive salt content in the soil, significant tracts of potentially rich land cannot be exploited for conventional crop cultivation (Rozema, 1991).

**Sources of Salinity:** Water table, soil profile, flooding, temperature, precipitation, improper irrigation system, runoff from lands and deforestation is marked as a major sources of salinity stress in soil. Irrigation

water itself is the major cause of soil salinity because when the water table rise salts will leach down in plant root zone that will affect the plant growth, leaf burning and defoliation and soil structure.

### Types of Salinity

**Primary salinity (Natural salinity):** Natural geological, hydrological, and pedological processes are responsible for the bulk of saline-sodic soils. Intermediate igneous rocks like phonolite, basic igneous rocks like basalts, undifferentiated volcanic rocks, sandstones, alluvial deposits, and lagoonal deposits are all parent materials for these soils (Wanjogu *et al.*). Salinization can be increased through climate change and water management. Evapotranspiration is particularly significant in the pedogenesis of saline and sodic soils in dry and semi-arid environments (ASAL). Much of the ASAL (Arid and Semi-arid land) receives less than 500 millimeters of annual rainfall, resulting in salinization when combined with an annual potential evapotranspiration of roughly 2000 millimeters (Ding *et al.*, 2020).

**Secondary salinity:** Human caused factors have salinized secondary salt-affected soils, generally as a result of inefficient irrigation systems. Low quality water is oftentimes utilized for water system, bringing about salt development in the dirt (Fitton *et al.*, 2019), salt affects 50 percent of all irrigated schemes. Water logging caused by inappropriate irrigation causes anthropic salinization in arid and semi-arid regions:-

- Due to the effect of salt movement in both the upper and lower layers, deforestation is recognized as a significant source of soil salinization and alkalization.
- Dry and non-irrigated landscapes, generally as a result of clearing vegetation and changes in land use.
- Seawater intrusion groundwater that has been over-exploited is replaced by seawater in coastal aquifer systems.
- Salty effluent from intensive agricultural and industrial wastewater is a point source.
- Chemical induced salinization in present era escalated horticultural frameworks, eminently nurseries and serious cultivating frameworks, this kind of salinization is getting more normal. In the event that synthetics are not eliminated consistently, salt watches out for gather in shut or semis hut frameworks (e.g., nurseries), bringing about saltiness or alkalinity.

Overgrazing this interaction happens fundamentally in dry and semi parched conditions, where regular soil cover is scanty and can't give the feed needs of huge creature cultivation. Overgrazing causes the natural vegetation to become scarce, resulting

in increasing salinization and, in certain cases, desertification as the poor pasture declines (Table 1).

### Reclamation of salt affected soils

Several techniques are adapted to reclaim salt-affected soils and efficiency of different methods depend on different factors. For example, soil factors, climate conditions, regional factors, availability and cost of amendments and so on. For the reclamation, salt affected soils is divided into two groups. 1) Saline 2) Sodic/ saline-sodic soils (Fig. 4).

### Reclamation of saline soils

In saline soils, excessive soluble salts present in the root zone and their reclamation is done by leaching with excess of good quality irrigation water that carries salts into the deeper soil layers. When we apply poor quality of water, salt concentration increases which means water has no more capacity to dissolved further salts.

### Reclamation of Sodic/saline-sodic

A soluble source of  $\text{Ca}^{2+}$ , such as gypsum, is given to the soil for reclamation of sodic/saline-sodic soils, followed by flooding with good quality irrigation water. The  $\text{Na}^+$  ions on the exchange complex are replaced by  $\text{Ca}^{2+}$ , which is then leached out of the root zone along with dissolved salts.

### Pre-requisites

There are certain essential pre-requisites for successful reclamation.

- 1) Availability of good quality water
- 2) Good internal drainage of soil
- 3) Deep ground water (preferably below 3m)
- 4) Land leveling

### Methods

1. Physical methods
2. Chemical methods
3. Biological methods
4. Hydro-technical method
5. Electro-reclamation method
6. Synergistic approach

### Physical methods

Most of the physical methods are used to improve the permeability of soil. Following are the physical methods for reclamation of salt-affected soil.

**Deep ploughing:** Ploughing to a depth of 40 cm to 150 cm is known as deep ploughing. On stratified soils with impermeable layers, this is a useful strategy. Following a series of tests, it was discovered that a single deep ploughing with a depth of 40 to 75 cm enhanced the calcareous sodic soils both physically and chemically. In some cases, sub-soiling also has a poor-quality soil which may be highly sodic, so that, in that place, deep ploughing is not recommended.

**Sanding:** In this practice, sand is mixed with the surface soil, soils which ae clay in nature having poor

infiltration rate. It enhances root penetration, water and air permeability, making salt leaching from the root zone easier. Sand should be mixed with at least 10 cm of surface soil for best effects (to improve permeability).

**Sub-soiling:** In sub-soiling, sub-soilers are used which consist of tines or blades up to the depth of 60-90cm. In this way, there is no inversion of soil, it only opens channels in soil and permeability increased. Sub-soilers are used to break hardpan of soils. Once the hardpan is broken, it means you improve the internal drainage of soil.

**Hauling:** This technique involves removing the surface of the salt-affected soil and replacing it with a layer of good-quality soil. Hauling is quite useful; however, it may not be appropriate in many situations because of its high cost.

**Horizon mixing:** When the soil profile has a good surface horizon but an unfavorable bottom horizon, this approach is applied. Such characteristics can be observed in saline-sodic/sodic soils with a favorable surface soil underlain by a slowly permeable, sodium-affected B horizon that is underlain by a more permeable gypsum horizon. The profile mixing method has the advantage of maintaining the surface soil while unravelling the subsoil and substratum. This is accomplished by removing the upper soil surface, mixing the underlining subsoil with the substratum, and then replacing the upper soil surface.

**Chemical methods:** To increase soil qualities and crop growth, chemical approaches involve chemical amendments. Chemical amendments are chosen based on a variety of variables, including their availability, cost, handling and application challenges, and the time required for them to react within the soil profile and reintroduce the adsorbed Na<sup>+</sup>. Chemical additives commonly utilized for saline-sodic/sodic soil rehabilitation can be divided into two categories:

**Inorganic amendments:** These can be further divided into three types:

- 1: Soluble calcium salts such as CaCl<sub>2</sub>, gypsum and phosphor gypsum.
- 2: Slowly soluble calcium salts like ground limestone (CaCO<sub>3</sub>),
- 3: Acidifying materials: These amendments increase the conversion of CaCO<sub>3</sub> to more soluble CaSO<sub>4</sub>, Ca(HCO<sub>3</sub>)<sub>2</sub>, Ca(NO<sub>3</sub>)<sub>2</sub>, or CaCl<sub>2</sub> in calcareous soils, mobilizing Ca<sup>2+</sup>. H<sub>2</sub>SO<sub>4</sub>, HCl, HNO<sub>3</sub>, Sulphur, pyrite (FeS<sub>2</sub>), lime Sulphur (CaS<sub>5</sub>), FeSO<sub>4</sub>, and Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> are examples of these amendments (Fig. 3).

**Organic amendments:** Normal and salt-affected soils both require organic matter to preserve, if not improve, their physical, chemical, and fertility qualities. Green

manures, farm manures, poultry manures, slaughter house waste, and other organic amendments are examples. For the reclamation of sodic soils, several organic polymers (polyvinyl alcohol, PVA) have been recommended. Some industry by-products, such as press mud and molasses meal from the sugar industry, may be beneficial for saline-sodic/sodic soil reclamation, but their widespread application is limited due to limited availability and sluggish reaction rates.

### Biological methods

The term "biological reclamation" refers to the process of reclaiming a salt-affected soil by planting crops on it. Organic materials added to salt-affected soils as farm yard/green manure is sometimes included under the same term. To minimize confusion between organic and biological amendments, use of manures/other organic materials to reclaim the sodic/saline-sodic soils must be done separately rather than simultaneously. Plant parts, both above and below ground, have a significant impact on soil. The mechanisms of biological reclamation could be linked to a long chain of different responses. These include the following:

- CO<sub>2</sub> release in the rhizosphere due to root and microbial respiration;
- Formation of carbonic acid (H<sub>2</sub>CO<sub>3</sub>) via CO<sub>2</sub> dissolution in water;
- Reaction of H<sub>2</sub>CO<sub>3</sub> with native CaCO<sub>3</sub> to form relatively more soluble Ca(HCO<sub>3</sub>)<sub>2</sub> release of Ca<sup>2+</sup> ions from Ca(HCO<sub>3</sub>)<sub>2</sub>; and
- Replacement of exchangeable Na<sup>+</sup> by Ca<sup>2+</sup>.

Plants that grow on saline/sodic soils produce a limited amount of biomass. Crop yields are lowered in salty soils due to the disruption of water and nutrient balance for plants, whereas plant growth is hampered in sodic soils due to poor physical conditions. Furthermore, in sodic soils, high Na<sup>+</sup> in the root medium disrupts plant nutrition. Plant species differ in their tolerance for soil salinity/sodicity and irrigation requirements, resulting in varying levels of growth efficiency. In calcareous salt affected soils, salt tolerant plant species generally perform better than non-calcareous soils. Their roots serve as Ca<sup>2+</sup> mobilizers in calcareous soils by dissolving the native CaCO<sub>3</sub>. The amount of soluble Ca<sup>2+</sup> in calcareous sodic soils farmed with salt tolerant plants was found to be sufficient in several experimental investigations for a significant reduction in salinity and sodicity levels. Biological reclamation of saline-sodic/sodic soils is often thought to be slower than applying inorganic amendments. Biological reclamation, on the other hand, can be initiated at a cheap cost.

### Hydro-technical method

Using this technique, saline water with a high electrolyte concentration is supplied to the soil, affecting its permeability, and so the “valence dilution” effect results from the constant addition of water for dilution purposes. In a soil water system with equal amounts of monovalent and divalent cations in solution and absorbed form, adding more water causes the equilibrium to shift toward the preferential adsorption of divalent cations like  $\text{Ca}^{2+}$  over monovalent cations like  $\text{Na}^{+}$ . When evapotranspiration causes the soil solution to become overly concentrated, the phenomena reverses. The lack of fundamental facilities for conducting this technique, such as saline water collection, transport, and reclamation, is the primary issue.

### Electro-reclamation approach

The electro-reclamation strategy can be characterized as the process of improving salt-affected soils by applying the electro-dialysis principle. Several research investigations, including laboratory and field experiments, show that using electric current for reclamation speeds up the process significantly, though it is not a perfect replacement for traditional reclamation procedures. This method of soil reclamation has yielded some promising findings, indicating that  $\text{CaCO}_3$  has a higher solubility, supplying more  $\text{Ca}^{2+}$  to replace the exchangeable  $\text{Na}^{+}$ . Furthermore, this approach generated a favorable environment for the leaching of soluble salts and exchangeable  $\text{Na}^{+}$ .

### Synergistic approach

Under certain conditions, such as a saline-sodic soil with an impermeable layer of 15 cm width at a soil depth, reclamation can be accelerated by combining the various reclamation processes. In this situation, combining physical and chemical approaches may be far more effective than using either chemical or physical strategy alone. This method is used for the reclamation of salt-affected soils by farmers in the majority of situations. The use of gypsum in combination with other organic amendments greatly reduced the salinity/sodicity problem. Gypsum in combination with various organic amendments, such as FYM, has been recorded (Murtaza *et al.*, 1999); combination of gypsum and sesbania green manure (Baig and Zia, 2006; Chang and Sipio, 2001) found that combining gypsum with rice husk had a significant impact on reducing salinity/sodicity. High cost of reclamation process is not affordable for all common person, that shows a low progress of sodic reclamation in country. It is highly suggested that the government give affordable gypsum on credit to poor farmers. Drought, chilling, freezing, high temperatures, and salinity are all abiotic stresses that plants undergo

during their growth and development. Stress can inhibit plant growth and development, decrease output, and even kill plants in the worst-case situation. In view of the low osmotic capability of the dirt arrangement and dietary lopsidedness, saltiness adversely affects plant physiology and biochemistry (Munns and Tester, 2008). Secondary stresses, such as oxidative damage, frequently develop as a result of these main effects of salt stress, which are generated by its hyperosmotic action (Zhu, 2001). Salinity is the most visible abiotic stress that has an impact on crop improvement and efficiency, and it is one of the world’s most well-known and widely dispersed natural problems. Salinity is characterized as an exorbitant grouping of dissolvable salts in the dirt that cutoff point’s plant development. Expanded saltiness is a basic issue that is a significant restricting element in worldwide rural efficiency (Wahid *et al.*, 2007). Around 30 g of sodium chloride per liter is found in the bulk of the world’s water. This has the potential to turn the earth into a very salty planet. Salt stress have a negative impact on plant shape, function, and homeostasis, as well as a reduction in plant biomass (Parvaiz, 2014). Because of the joined impacts of high osmotic potential and explicit particle harmfulness, high soil saltiness can incredibly impede seed germination and seedling development. Salt pressure adversely affects plant capacity and digestion, which fundamentally lessens usefulness. Salinity has a variety of effects on plants; for example, salt in the soil solution reduces water accessibility to the roots, and salt stored in the plant will rise to dangerous levels in numerous plant tissues. Many crops’ seed germination hampered by salinity, which creates an osmotic potential outside the seed, preventing water absorption, or by the toxic effects of  $\text{Na}^{+}$  and  $\text{Cl}^{-}$ . Salinity stress lowers plant development in tomato (Romero-Aranda *et al.*, 2001), cotton (Meloni *et al.*, 2001), and sugar beet (Meloni *et al.*, 2001), according to several research (Ghoulam *et al.*, 2002). However, there are differences in salinity tolerance between species and cultivars, as well as among the numerous plant growth traits studied. *Rhizophora mucronate* plants grew best in 50 percent seawater and reduced as salinity increased, but total plant weight increased in *Alhagi pseudoalhagi* (a leguminous plant) at low salinity (50 mM NaCl) but decreased at high salinity (100 and 200 mM NaCl) (Kurban *et al.*, 1999). Fresh and dry mass of sugar beet leaves and roots were significantly reduced at 200 mM NaCl, whereas leaf number were unaffected (Ghoulam *et al.*, 2002). Working with sultana vines, (Fisarakis *et al.*, 2001) discovered that shoots accumulate more dry matter than roots, especially at high NaCl concentrations, indicating that photo

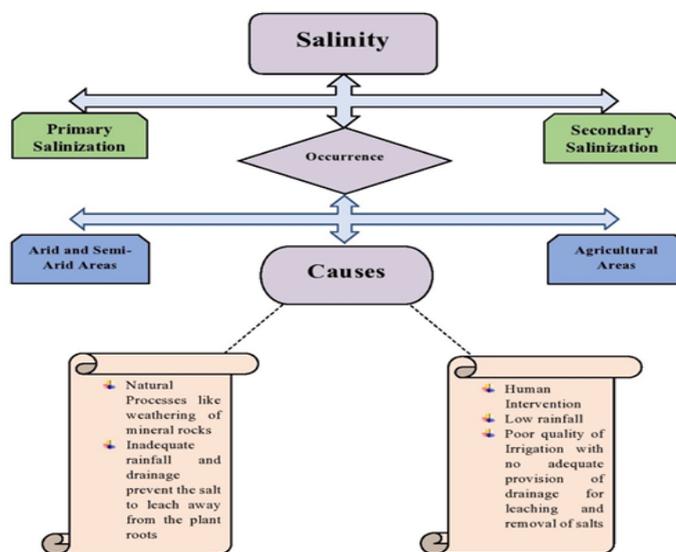


Fig 1: Schematic diagram to show types of salinity.

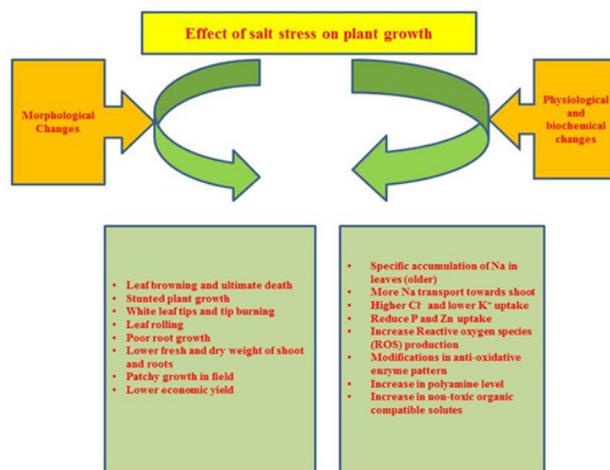


Fig 2. Influence of salt stress on plant morphology, physiology and biochemistry

Table 1: Classification of salt affected soils

Type of salt effected soil	EC (ds/m)	pH	ESP	SAR	Soil physical condition
Saline	≥ 4	< 8.5	< 15	< 13	Normal to poor
Sodic	≥ 4	> 8.5	≥ 15	> 13	Very Poor
Saline sodic	< 4	< 8.5	≥ 15	> 13	Poor

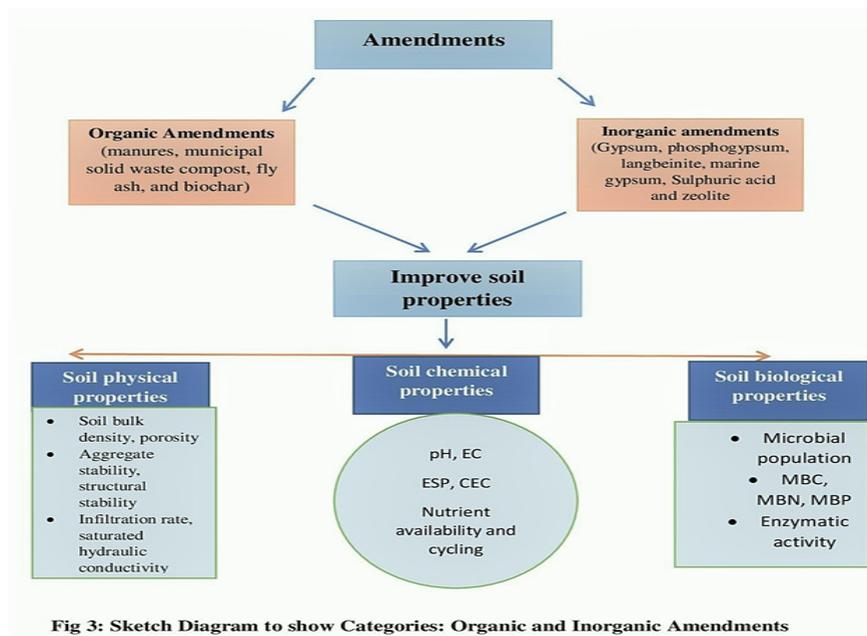


Fig 3: Sketch Diagram to show Categories: Organic and Inorganic Amendments

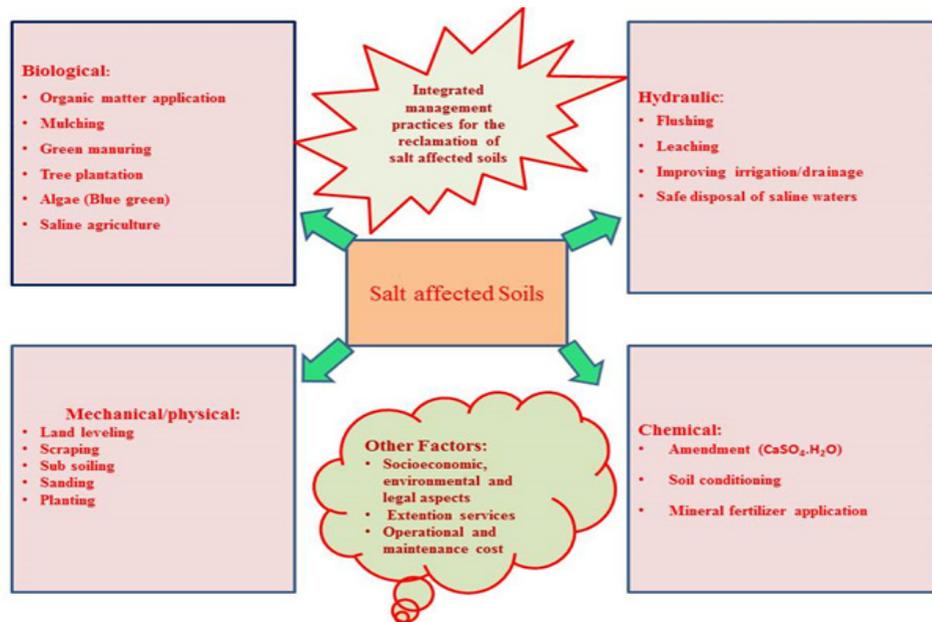


Fig 4. Integrated management practices for the reclamation of salt affected soils

assimilate partitioning favors roots. They hypothesized that the enhanced ability of the roots to change osmotic pressure under stress was responsible for the outcomes.

### **Effect of Salinity on Photosynthesis**

Photosynthesis is required for plant growth, thus environmental conditions that impact growth also affect photosynthesis. Salinity inhibited photosynthetic activity in a variety of plant species, according to research undertaken by a number of scientists (Romero-Aranda *et al.*, 2001). Salinity-induced decrease of vegetative growth was found to be accompanied by a considerable reduction in photosynthesis (Fisarakis *et al.*, 2001). Depending on the salt amount and plant species, salinity has a variable effect on photosynthetic rate. In *B. parviflora*, photosynthetic index increased at low salinity and decreased at high salinity, whereas stomatal conductance stayed constant at low salinity and decreased at high salinity (Parida *et al.*, 2004). (Iyengar and Reddy, 1996) discovered a number of factors that contribute to decreases in photosynthetic rate as a result of salinity: (1) Cell membrane dehydration, resulting in a reduction in CO<sub>2</sub> permeability (Safdar *et al.*, 2019). Osmotic potential is increased by high salt concentrations in soil and water, lowering the amount of water available to plants. Osmotic pressing factor is carried out with the aid of using a reducing in water potential, which reversibly inactivates photosynthetic electron transport with the aid of using contracting intercellular space. (2) The salt toxicity is heavily influenced by the Na<sup>+</sup> and Cl<sup>-</sup> particles. Cl<sup>-</sup> diminishes photosynthetic rate by hindering NO<sub>3</sub>-N take-up by the roots. Fisarakis *et al.* (2001) discovered that in salt-stressed sultana vines, NO<sub>3</sub>-N was greatly reduced, and that this reduction was connected with photosynthetic decline. The inhibitory effect of salinity on photosynthesis could be explained by lower NO<sub>3</sub>-N absorption paired with osmotic stress. (3) The closure of stomata results in a reduction in CO<sub>2</sub> supply. As stomatal conductance decreases, the amount of CO<sub>2</sub> available for carboxylation processes decreases. According to (Iyengar and Reddy, 1996) stomatal closure reduces water loss through transpiration, which modifies chloroplast light harvesting and energy-conversion processes, resulting in alterations in chloroplast activity. Increased CO<sub>2</sub> diffusion into the leaves has been observed in plants with higher stomatal conductance, favoring higher photosynthetic rates. As (Radin *et al.*, 1994) discovered in Pima cotton, higher net assimilation rates may induce larger crop yields (*Gossypium barbadense*). However, for six Brassica species, (Ashraf, 2001) found no significant relationship between photosynthetic rate and stomatal conductance. Under salt stress, there has also been

evidence of nonstomatal photosynthetic suppression. (Iyengar & Reddy, 1996) discovered three additional explanations of lowered photosynthetic rates caused by salinity: (4) increased salt-related senescence, (5) changes in enzyme activity resulting from changes in cytoplasmic structure, and (6) poor feedback resulting from decreased sink activity. Several traces of proof mean that even as the rate of photosynthesis is decreased below salt stress, this isn't the supply of the discount with inside the rate of cell expansion.

### **Remediation of salinity organic amendments and phosphorus fertilizers:**

Saline soils are an essential natural resource, but due to climate change and limited rainfall, the amount of degraded saline soils has rapidly risen around the world, posing a serious threat to global food security. A targeted remediation effort for such soils could remedy this problem. In addition, deficit irrigation is expected to enhance soil salinity and sodicity, especially in dry and semi-arid climates, necessitating effective management measures to prevent soil degradation. Heavy metal contamination of soils has become a worldwide concern due to the potentially harmful effects of these ions on soil quality, crop production and quality, food safety, and human health (Antoniadis *et al.*, 2017). Organic fertilizers additions have been used to remediate saline soils, relieve salinity and sodicity stress on crops, and minimize heavy metal toxicity. Organic additives have the potential to improve soil characteristics by speeding up sodium and other salt leaching and lowering the exchangeable sodium percentage (ESP) (López-Valdez *et al.*, 2010). Furthermore, organic additions improve soil biological and enzyme activity as well as organism abundance, resulting in increased soil fertility and crop production (Ding *et al.*, 2020). However, further research is required to determine how organic amendments and irrigation regimes affect saline and alkaline soils. Phosphorus (P) is an essential ingredient for plant development and growth (Alotaibi *et al.*, 2018). The amount of P fertilizers required to ensure a sustainable food supply will be doubled as a result of the world's rapid population expansion. Arid soils have significantly less available P than wet soils due to reduced total P and higher P fixation in soils. In a dry environment, salt leaching is limited, resulting in calcium (Ca) mineral formation. The majority of water-soluble P supplied to soils in fertilizers is swiftly transformed to other, less available forms. Chemical fractionation of soil P could reveal more about the mobility and availability of P in soils (Ahmad *et al.*, 2018). However, no further research on the effect of P fertilizers on soil P fractionation at the field scale, particularly in dry and semi-arid habitats, has been done. More efficient P

usage, as well as reducing the environmental impact of mineral fertilizers, are crucial in this situation. This may be accomplished by combining P mineral fertilizers with organic amendments, but this would require more attention. To rehabilitate saline soils, poultry manure, crop straw and factory residue, farmyard manure (FYM) sewage sludge (SS) and Press mud have all been used, with some of them being untreated and affordable. The SS has been recognized as a beneficial wheat fertilizer that increases soil organic matter content, but more research is needed in field. Press mud have a sufficient quantity of P. Furthermore, the interaction of soil amendments and irrigation in salty soils has not been thoroughly investigated. Phosphate fertilizers have been shown to boost crop production (Ademba *et al.*, 2015) and soil microbial activity, but just a few researches have looked at saline alkaline soils. Crop growth yield and quality of wheat improved significantly in response to the integrated application of mineral P and organic amendments. In conclusion, the combination of mineral P sources with organic amendments could be successfully used as a cost-effective management practice to enhance soil fertility and crop production in the arid and semi-arid regions stressed with water scarcity and natural resource constraints (Ding *et al.*, 2020).

#### **Growing wheat on saline lands**

Wheat is the world's third-largest cereal producer, accounting for more than 20% of the calories consumed by humans worldwide (Le Gouis *et al.*, 2020). Wheat production and productivity have a direct impact on human survival in developing countries as well as the standard of living in developed countries. The world's population is rapidly increasing. Because of the scarcity of land for agricultural production, it is one of the most pressing challenges for present and future food supplies (Fitton *et al.*, 2019). Progressive salinization has an impact on the amount of land that can be used for agriculture. The only way to ensure food security is to keep increasing the production and productivity of main crops like wheat. One of the most important ways for increasing productivity is to use saline land for wheat farming. Further, especially centered around propelling saltiness troubles in farming area, salt resilience system in wheat and presence of hereditary variety in wheat and its application in reproducing for salt resistance (Ding *et al.*, 2020).

#### **Wheat's Salt Tolerance Mechanism**

Abiotic stressors, such as soil salinity, influence plant growth and development through altering cytosolic  $K^+$ / $Na^+$  ratios and osmotic tension through ion cytotoxicity. These processes disturb plant cell distribution and homeostasis, causing functional and structural proteins

to denature. Most enzymes in moderately salt sensitive plants diminish their activity as the  $Na^+$  concentration approaches 100 mM, according to in vitro research. By dismissing  $Na^+$  at the plasma film, sequestering  $Na^+$  in intracellular vacuoles, and aggregating osmolytes and osmoprotectants, a few plant animal categories have advanced to continue in saline soils (Ding *et al.*, 2020). Plants can keep up legitimate  $K^+/Na^+$  proportions and ideal cell osmolarity in saline soil circumstances by advancing such frameworks. Physiological, biochemical, metabolomic, and genomic cross talk oversee singular salt resistance pathways in plants during resilience responses. Plasma film  $H^+$  - ATPase, which uses the energy of ATP hydrolysis to produce an electrochemical  $H^+$  angle to expel  $Na^+$  in salt lenient plants, bars  $Na^+$ . Animals, fungi, and a variety of plant taxa have been found to have  $Na^+/H^+$  antiporters, according to biochemical research. Similarly, endogenous  $H^+$ -ATPase is required for the establishment of  $Na^+$  and Clinflux via  $Na^+/H^+$  anti-porters and chloride channels, respectively (Janicka-Russak, 2011).

#### **To improve a wheat plant's salt tolerance**

Wheat (*Triticum aestivum* L.) categorized as a moderately salt tolerant crop by (Maas & Hoffman, 1977) in their classic work on salt tolerance classification. The introduction of salt tolerance genes into adapted cultivars has been proposed as one technique for enhancing salt tolerance in wheat (Munns, 2005), screening large germplasm collections, detailed field trials of selected cultivars (Munir and Aftab, 2011) conventional breeding methods (Salam *et al.*, 1999) and unconventional crosses with wild relatives (Colmer *et al.*, 2006).

#### **Salinity and grain yield in relation to each other**

Grain yield estimates add to the complexity of the salinity response, not only because crops must be grown under uncontrolled conditions for long periods of time, but also because it is difficult to convert shoot biomass to grain biomass (Fitton *et al.*, 2019). The salt content ('threshold value') and a harvest index that increases with the salt content show that a small amount of salt cannot influence grain production, even if the leaf area and the shoot biomass decrease. The US Salinity Laboratory published a comprehensive study on crop and pasture salt tolerance (Maas and Hoffman, 1977), which indicates that each species has a yield limit beyond which there is no reduction in production, and then a direct decline in output as salinity grows (a 'twisted stick' connection). Rice yields start to fall at 3 dS mL (30 mM NaCl), but wheat yields start to fall at 6–8 dS mL (60–80 mM NaCl), and rice yields decline twice as fast as wheat with rising salinity. Other studies have found that the relationship between yield and salinity is sigmoidal rather than "bent stick," leading to the

recommendation that using an EC50 (EC that leads in a 50% yield reduction) to compare genotypes is more informative than using a linear rate of decline (Royo *et al.*, 2000). Royo *et al.* (2000) find a 30–40% lower salt tolerance in barley and durum wheat, respectively.

This presents the issue that genotypes chosen in one climate may not be proper for an alternate climate. Field conditions shift from one spot to another, as far as soil saltiness, yet in addition as far as the physical and substance properties of the dirt, including sodicity, high pH, and possibly hurtful minor components like boron (Rengasamy, 2002). Furthermore, there are periodic changes in temperature and dry season, which directly affect the salt development encompassing the roots, especially in dry-land agriculture. There are sporadic fluctuations in temperature and dry spells, which will directly affect the salt formation encircling the roots, especially in dryland agriculture. Changes in blooming or maturity timelines between genotypes could create significant production disparities if the environmental conditions change during the flowering or grain filling period. Waterlogging and salinity are intricately connected in many soils. In countries like Pakistan, irrigation water with a high “sodium hazard” (high sodium absorption ratio) deteriorates fine-textured soils, while insufficient water infiltration promotes salinization (due to irrigation water evaporation at the soil surface) and waterlogging (Qureshi and Barrett-Lennard, 1998). When water tables rise to within 2 meters of the soil surface or near the root zone in Australia, secondary salinity develops. Because the earth has an average of 10% air-filled porosity, water tables can rise to the surface with just 100 mm of rain, putting plants under salt and waterlogging stress at the same time (Barrett-Lennard, 2002). Salt tolerance in different environments is rarely graded among genotypes. The magnitude of genotype environment interactions is unknown, although it is likely to be significant.

### Other cereals' salt tolerance

Grain is one of the most salt-tolerant crops (Maas and Hoffman, 1977). Because of its rapid development and phenological improvement, which motivates an early development date, it has increased salt resistance in the field. The difference in salt tolerance between barley and wheat becomes less noticeable when developmental differences between the two crops are taken into account. In a greenhouse study of the salinity response in some vegetative phases, there were modest differences in biomass production in salinity between different varieties of barley, wheat and triticale more salt tolerant than both normal and fast-growing bread wheat varieties, and some cereals were more

salt tolerant than others (Rawson *et al.*, 1988). Saline in both greenhouses and field research. The Kna1 locus appears to be deficient in grain compared to wheat, as evidenced by high Na<sup>+</sup> and low K<sup>+</sup> bonds. Although there are varietal differences in the accumulation of Na<sup>+</sup> and Cl in the leaves. The connection between the accumulation of Na<sup>+</sup> and Cl and the salt resistance of the grain has not been demonstrated in the same way as in wheat and rice (Colmer *et al.*, 2005). Gregorio *et al.* (2002) looked at how far rice breeding has progressed in terms of salt tolerance. Soma clonal varieties, another culture-inferred lines, and atomic marker-helped determination have all been utilized as of late to expand the salt resilience of current rice cultivar. Ren *et al.* (2005) recently identified OsHKT8 as a potential SKC1 candidate gene). A reproducing program requires a comprehension of physiological and hereditary standards to pick the ideal aggregate in different hereditary foundations. Prior to investigations of adding new qualities for salt resistance, the communicated attribute should be chosen in back-got lines that go through seed duplication. Na<sup>+</sup> ‘prohibition,’ K<sup>+</sup>/Na<sup>+</sup> segregation, tissue resilience, particle maintenance in the leaf sheath, particle apportioning into various matured leaves, happening proficiency, osmotic change, early energy, and early blossoming are generally factoring that add to a more limited developing season and more effective water use (Colmer *et al.*, 2005)

### CONCLUSION

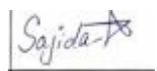
An ideal sustainable agricultural system maintains and enhances human health, provides economic and spiritual advantages to producers and consumers, preserves the environment, and produces adequate food for a growing global population. To sum up, salt pressure in plants is getting a greater amount of an issue in agribusiness, in spite of the fact that it influences a wide scope of plants and environments. It causes a lack of water and ionic toxicity in plants, slowing down key plant functions like photosynthesis and metabolism. Soil physical and chemical parameters improved significantly when P fertilizers and organic amendments were applied, as did wheat yield and quality attributes. However, just a few studies on salt tolerance mechanisms in wheat have been conducted, which can be used in salt tolerance breeding. Quick improvement in genome sequencing endeavors in huge yield species, just as the advancement of immense quantities of knockout freaks and their portrayal in model plants like rice, would be helpful to family members like wheat. The role of metabolites in salt resistance instruments will be investigated so that the biochemical and physiological cycles that

contribute to salt tolerance may be properly understood.

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