

Mungbean under Salinity Stress: Challenges, Research Frontiers and Emerging Strategies for Crop Improvement towards Social Food Security

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Abstract

Mung bean holds significant importance contributing food security, agriculture, national economy and human nutrition. Being a vital dietary element, productivity of mungbean is severely reduced by various abiotic stressors, predominantly salinity stress, which has emerged as a foremost constraint in semi-arid and arid areas because of climatic alterations, deprived irrigation practices, and extreme application of fertilizers. The development of salinity-tolerant mungbean cultivars requires the identification and utilization of novel genetic variability associated with key stress-responsive traits. It remains challenging due to the complex genetic regulation of stress responses, limited tolerant germplasm, and genotype-specific variability. Present review highlights the importance of integrating salinity stress physiology, tolerance mechanisms and management strategies to develop salinity tolerance in mungbean for sustainable production that would ensure national nutritional food security. Furthermore, the integration of physiological, biochemical, molecular, and advanced breeding approaches, along with genotyping and sustainable crop management practices, can facilitate the development of climate-resilient mungbean varieties suitable for saline environments. Such integrated strategies may exert significant impacts in promoting climate-smart agriculture, sustainable mungbean production, and long-term nutritional and food security.

Keywords: Mungbean; Salinity stress; Adverse effects and challenges; Emerging integrative salinity tolerance strategies; Sustainable crop production.

Introduction: Climate Change and Salinization of Arable Land

Climate change significantly affects agricultural productivity worldwide by accelerating soil degradation processes such as salinization, acidification, and nutrient imbalance, principally in semi-arid and arid areas. These adverse changes influences growth, development, and yield stability of almost all agricultural valuable crops by altering temperature, precipitation patterns, and atmospheric CO₂ concentrations. Increasing incidences of drastic weather conditions at present poses major threats for sustainable yield production nutritional food security worldwide (Mustafa et al., 2019; Hasanuzzaman and Fujita, 2022). Tropical agricultural systems are highly vulnerable to climate variability due to increased pest incidence, disease outbreaks, and environmental stress conditions. Creating crop varieties that are climate-resilient and using sustainable farming methods are crucial tactics to lessen the drastic impact of climatic variations and guarantee long run food security forrising population (Manjeet et al., 2023; Yuan et al., 2024).

A significant worldwide issue that affects food security and agricultural production is salinization. As per the FAO, major portion of the top and sub soil (nearly, 424 and 833 million hectares respectively) get affected due to salinity, making up almost 73% of the world's mapped land. Approximately, 20% of the land watered by various irrigation practices turned into saline soil. Increase in salinity problem is broadly associated with altered climatic conditions, rise in sea-level rise, desiccation problem or drought, and improper irrigation practices, which together threaten sustainable agriculture and ecosystem stability. According to reports, there are approximately 17 million km² of salt-affected soil worldwide that have strong possibility for saline agriculture, hence needsalt-resilient crops and appropriate management practices (FAO and ITPS. 2021; Basak et al., 2022; Negacz et al., 2022). In India, continuously increase in salinity affected provinces represent a serious constraint to sustainable agricultural production, especially in irrigation based agriculture areas, semi-arid and arid areas, and coastal belts where poor drainage, over-irrigation, and rising groundwater tables accelerate salt accumulation (Mandal, 2024). It degrades the soil structure, and can threaten the sustainability of agriculture and food security throughout India. Coastal and arid to semi-arid regions are the most vulnerable to salinity problems (CSSRI, 2015; Mandal et al., 2025). Recent spatial studies from the Indo-Gangetic Plain show that both saline and sodic soils persist even in previously reclaimed areas,

indicating that long-term monitoring and improved land management practices are essential to prevent re-degradation (Mandal, 2024). In addition, advanced geospatial and decision-tree-based analyses have improved the regional mapping of soil salinity, enabling better identification of highly affected zones and supporting precision reclamation strategies (Ghorbani et al., 2025). Earlier studies conducted also highlighted that the soil chemical imbalance, especially high SAR (sodium adsorption ratio), pessimistically affects soil structure, microbial activity, nutrient availability, thereby reducing crop establishment and yield stability (Narjary and Kumar, 2026). These studies emphasize an urgent need for effectual management strategies or practices and utilization of saline soils to support future food production and agricultural sustainability.

Mungbean under Salinity: A Serious Concern for Sustainable Production

Mungbean is a crucial short-duration (55–80 days) pulse crop cultivated in sub-tropical and tropical expanses. It is widely cultivated in different agro-ecological areas across India under both irrigated and rainfed conditions. Mungbean plays significant role in sustainable agriculture and food security. This crop is valued for its high nutrition value (i.e. protein content and dietary fibers; Figure 1), easy digestibility, human health significance, wide adaptability, low input requirement, soil fertility improvement due to efficient nitrogen fixing ability, suitability for crop rotation and intercropping systems (Kamaleshwaran et al., 2025; Surya et al., 2026). This nutritious crop also has gut health promoting effects and pharmacological significance in current scenario to manage human illnesses and chronic diseases. Valuable bioactive compounds of mungbean have great potential to regulate enzyme functions, metabolism, cellular processes and immune functions that collectively support organ functions and results in significant health outcomes as functional food (Sehrawat et al., 2020; 2023; 2024).

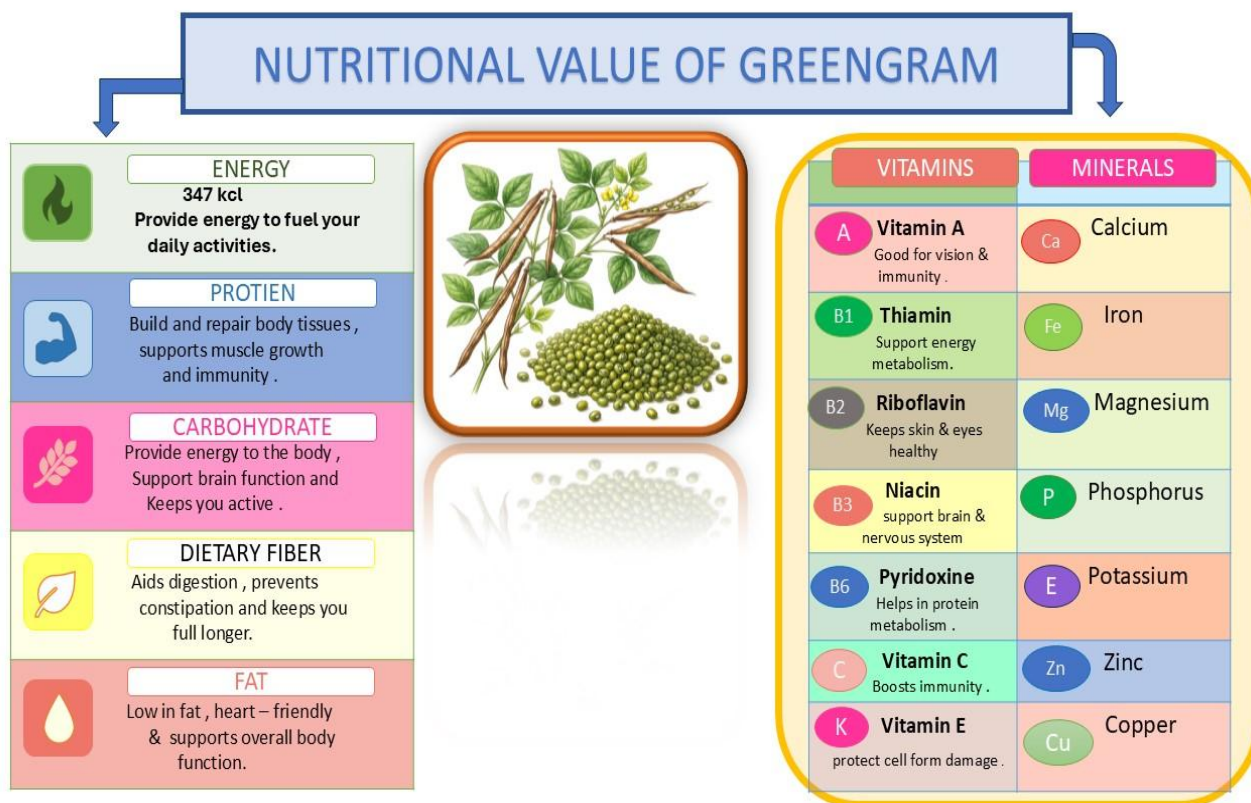


Figure 1: Potential health significance of mungbeanas functional food.

Since mungbean is a vital dietary component of food in South Asian nations with dense populations and poor economies, production must rise to keep up with the growing demand. However, mungbean farming is seriously threatened by the ongoing expansion of territory contaminated by salt (Sehrawat et al., 2019; Breria et al., 2020; Liu et al., 2022). Soil salinity as major abiotic stress significantly limits seed germination rate, establishment of seedling, plant development, survival, yield, productivity, and sustainability of legume crops, particularly mung bean, which is valued as great protein source and significant adaptability towards variable agro-ecological regions (Sehrawat et al., 2015; Bouzroud et al., 2023; Singh et al., 2025).

Increasing salinity, driven by global warming, excessive irrigation using saline water, and intensive fertilizer use, disrupts plant physiological and biochemical processes by causing excessive accumulation of Cl^- and Na^+ toxic ions causing osmotic stress, ionic imbalance and unbalanced nutrients (Kaur et al., 2024; Preet et al., 2024; Suriya et al., 2026). These conditions adversely affect seed germination process, establishment of seedlings, phases of plant growth and development, and overall biomass production. Several studies recorded that increase in salinity

result in momentous reduction or delay in germination of seeds, seedling establishment and growth characteristics (Miajy et al., 2024). Moreover, high buildup of toxic ions causes membrane instability, nutrient disparity, and inhibition of hydrolytic enzymes responsible for mobilization of stored food reserves in seeds (Islam et al., 2025).

Salinity generated osmotic as well as ionic stress limits water uptake, and reduces cell turgor that finally causes decreased cell expansion, reduced plant biomass and yield production (Patel et al., 2024). In addition, salinity negatively affects chlorophyll synthesis, stomata closure, photosynthetic efficiency, hormonal balance, and root development, damages cellular structures and enzymes, leading to poor plant establishment and reduced crop productivity (Islam et al., 2025). Nutrient imbalance as reduced uptake of potassium (K^+), calcium (Ca^{2+}), and nitrogen under saline conditions, further limits plant growth, development and production. Moreover, salinity adversely affects root nodulation and nitrogen fixation, leading to reduced nitrogen availability and consequently lower biomass accumulation. Beside this, excessive ROS production under salt stress causes oxidative damage to the cellular components (proteins, lipids, chloroplasts, and nucleic acids), ultimately impairs cellular metabolism, seedling establishment, suppress growth and plant biomass (Bouzroud et al., 2023). Overall, continuous increasing soil salinity leads to a significant decline in crop performance and yield attributes in mungbean but this response is variable depending on stress severity and varietal tolerance (Sehrawat et al., 2019; Bouzroud et al., 2023). Despite these detrimental effects, significant genotypic variation exists among mung bean cultivars towards imposed salinity. The salt-tolerant genotypes exhibit adaptive responses as maintenance of ionic balance, enhanced activity of antioxidants, osmoprotectant accumulation, and efficient exclusion or compartmentalization of toxic ions. Experimental findings indicate that tolerant lines show relatively lesser reductions in growth and biomass under saline conditions, and in some cases, even slight increases in fresh and dry biomass have been observed in moderate saline environment (Singh et al., 2025; Suriya et al., 2026).

Promising Etiology for Salinity Induced Adverse Effects

Salt stress disrupts several biochemical events and physiological functions in crop plants which significantly reduces plant growth and biomass. Salinity reduces soil solution's osmotic potential thereby restricting water absorption essential to activate metabolic reactions and enzyme activity

required for seed germination (Okumuş and Şekerci, 2024). Moreover, salinity induced ionic stress alter the concentration of key ions regulating cellular processes and molecular events involved in plant establishment. In addition, essential cellular machinery get damaged because of oxidative stress induced by ROS accumulation under salinity that further impairs cellular metabolism, arrest plant proper development and production (Bouzrout et al., 2023). According to research findings, Cl^- toxicity in mungbean leaf tissue is mostly responsible for the negative effects of salinity (Le et al., 2021). The mungbean plants accumulate more Cl^- ions in leaves in comparison to root part while attempting to maintain lower Na^+ in its leaves. This could be because roots intercept Na^+ and restrict its transit to shoots, preventing toxicity and buildup of Na^+ in leaves. High leaf Cl^- concentrations may be greater than vacuoles' capacity to store them, allowing chloride ions to enter and build up in the cytoplasm and organelles and causing harm (Oi et al., 2022).

Insights into Tolerance Mechanisms towards Salinity

Crop salinity tolerance including mungbean, is linked to a number of mechanisms that control accumulation of Na^+ and Cl^- ions up to toxic level. These mechanisms include: i) osmotic adjustment by osmoprotectant synthesis and ion uptake (K^+) process; ii) ionic homeostasis mediated by either exclusion of sodium ions (capability of plant's roots to restrict Na^+ entry while water and nutrients absorption) or sodium ion compartmentalization inside vacuole that provide tissue level tolerance and prevent buildup of ion toxicity in cytoplasm and leaves by maintaining high K^+/Na^+ ratio; and iii) the up-regulation of plant's antioxidant defense system (non-enzymatic and enzymatic pathway) to scavenge oxidative reactive species (Munns et al., 2016; Oi et al., 2022; Chaurasia et al., 2024). Coordinated reactions are needed for salinity tolerance, including tissue/cellular compartmentalization of salt in leaves and salt exclusion in roots. Salinity tolerance in plants is increased by genotypes that are better able to keep Na^+ and Cl^- out of shoots, control ionic toxicity in chloroplasts of mesophyll cells, and maintain elevated K^+ in mesophyll cells and root (Kaur et al., 2022; Iqbal et al., 2024). Efficient nutrient management and raising of tolerant crop genotypes in saline soil are some methods for enhancing salinity tolerance in plants. However, a plant's ability to withstand salinity also depends on its cultivar and how well it is fertilized. While using salt-tolerant crops does not completely eradicate salt, it does cause it to build up. Other agronomic techniques, such as phytoremediation

for salt removal, are costly and time-consuming (Ibrahimi et al., 2025). Suitable integration of salinity tolerance approaches to develop climate smart agriculture practices may contribute fruitful outcomes for sustainable mungbean production on saline soil.

Recent Key Findings on Mungbean for Salinity Tolerance

Soil salinity is continuously increasing because of excessive fertilizer use, severe climatic alterations, and unhealthy irrigation practices. Studies reported that increasing salinity levels from moderate to severe stress conditions drastically decreased germination and seedling growth traits in mungbean genotypes, while tolerant cultivars maintained relatively higher germination rates and lower ion leakage in contrast (Sehrawat et al., 2014; Jafarullakhan et al., 2024). Tolerant mungbean genotypes can withstand salinity by maintaining ion homeostasis, enhancing antioxidant enzyme activities, accumulating osmolytes (i.e. soluble sugars and proline), and improving stress-responsive physiological mechanisms. Current investigations have shown that seed priming, nanoparticle application, and biostimulants improve germination and seedling growth in saline soil by improving osmotic adjustments and plant's antioxidant defensive mechanisms (Chauhan et al., 2023; Sherpa et al., 2025). Few key studies carried out on mungbean under salinity stress are presented in Table 1.

Table 1: Various investigations carried out on salinity tolerance in mungbean and their key findings.

Mungbean Genotype Used	Salinity Level Used	Observations studied	Important Findings	Reference
Mungbean (<i>Vigna radiata</i>) under salinity and high temperature stress	Different saline field and controlled conditions	Photosynthesis, Na ⁺ /K ⁺ uptake, antioxidant activity, reproductive traits, water relations	Salinity tolerance was associated with efficient Na ⁺ exclusion, osmotic adjustment, and antioxidative defense mechanisms.	Hanumantha Rao et al., 2016
Green gram varieties	Salinity (0–12 dS m ⁻¹)	Germination %, root and shoot growth	Increasing salinity drastically reduced seedling growth	Prakash et al., 2017
<i>Vigna radiata</i> treated with manganese supplementation	Salinity stress conditions	Relative water content, SOD activity, proline, reducing sugars, yield attributes	Mn supplementation enhanced antioxidant defense and improved yield under salinity stress.	Shahi et al., 2020
Seventeen mungbean varieties (<i>Vigna</i>	100–400 mM NaCl	Seed germination, seedling vigor, root and shoot length,	Increasing salinity progressively reduced germination and seedling	Mankar et al., 2021

<i>radiata</i> L.)		biochemical responses	growth; tolerant varieties accumulated more osmolytes and maintained better growth.	
<i>Vigna radiata</i> grown under silicon supplementation	10, 20 and 50 mM NaCl + 1 and 5 mM sodium silicate	Biomass, nodulation, chlorophyll, ROS accumulation, MDA, electrolyte leakage, Na ⁺ /K ⁺ ratio, antioxidant enzymes	Silicon at 5 mM markedly reduced oxidative damage, improved Na ⁺ /K ⁺ homeostasis, enhanced photosynthetic machinery, and alleviated salinity stress.	Murad and Muneer, 2022
<i>Vigna radiata</i> treated with nano-iron and nano-zinc	Nanoparticle exposure under stress-associated conditions	Chlorophyll, protein content, enzymatic antioxidants, growth parameters, metabolic changes	Nano-iron and nano-zinc improved metabolic activity, antioxidant defense, and growth performance, suggesting potential roles in abiotic stress mitigation including salinity.	Rani et al., 2022
Mungbean (<i>Vigna radiata</i>) sprouts	Salinity stress treatment during sprouting	Metabolomics, transcriptomics, amino acid metabolism, flavonoids, stress-responsive genes	Salinity altered metabolite profiles and activated stress-responsive metabolic pathways associated with osmotic adjustment and antioxidant defense.	Lim et al., 2022
Mungbean under saline soil	Seed priming	Germination and growth traits	Priming improved osmotic adjustment and germination	Chauhan et al., 2023
Mungbean seedlings	Salinity (NaCl) stress	• Oxidative stress and ROS • Osmoprotectant accumulation	• Increased ROS accumulation and membrane damage under stress • Increased proline and soluble sugars under stress	Bouzroud et al., 2023
<i>Vigna radiata</i> under silicon-mediated salinity stress	Different NaCl concentrations with silicon supplementation	Gas exchange traits, soluble proteins, phenolics, nitrate reductase activity, ROS, proteomics, transporter gene expression	Silicon regulated salt-responsive genes and silicon transporter genes while improving antioxidant defense and physiological performance under salinity.	Murad and Muneer, 2023
Mungbean inoculated with salinity-tolerant endophytic bacteria	Salinity stress under controlled conditions	Plant growth, chlorophyll, antioxidant activity, nodulation, nutrient uptake	Endophytic bacteria improved growth, nodulation, chlorophyll content, and stress tolerance under saline conditions.	Zahra et al., 2023
<i>Vigna radiata</i> cultivars NM-92 and Ramzan	0, 50 and 100 mM NaCl	Biomass, chlorophyll a & b, nitrate reductase, proteins, amino acids, Na ⁺ , K ⁺ , Ca ²⁺ , Mg ²⁺	Salinity significantly reduced growth and chlorophyll content. Potassium supplementation improved chlorophyll stability, ion balance, osmotic balance, biomass,	Shani et al., 2024

			and physio-biochemical traits under salt stress.	
Different mungbean genotypes (<i>Vigna radiata</i>)	Salt stress conditions (NaCl-mediated stress)	Germination, root/shoot growth, chlorophyll, antioxidant enzymes, membrane stability	Salt-tolerant genotypes maintained better membrane stability, antioxidant defense, and chlorophyll content than sensitive genotypes.	Patel et al., 2024
Mungbean accessions (BD-6882, BD-10022, BD-10024)	Salinity (8 dS m ⁻¹)	Germination and dry matter	Salt-tolerant accessions maintained higher dry biomass and identified for breeding	Miajy et al., 2024
Mungbean genotypes	Salt and temperature stress	Germination behavior under combined stress	Salinity with high temperature severely reduced germination	Okumuş et al., 2024
Mungbean cultivars	Salinity stress	Classical and molecular breeding	Marker-assisted breeding useful for salt tolerance	Jafarullakhan et al., 2024
Mungbean cultivars K1, Co6, Co7(Gg), and Co8	10 and 20 mM NaCl + 5 mM silicon fertigation	Photosynthesis, transpiration, antioxidant enzymes (SOD, CAT, APX), yield traits, chlorophyll, membrane stability	Silicon fertigation improved photosynthetic efficiency, antioxidant activity, and yield performance under saline conditions, especially in Co7(Gg) and Co8.	Sadhanandan et al., 2025
Diverse mungbean accessions (<i>Vigna radiata</i>)	Multi-stage salinity screening	Germination, biomass, pod yield, chlorosis scoring, GWAS and genomic prediction	• Genomic regions for salt tolerance identified • Significant genetic variability and salt-tolerant loci were identified through phenotyping and genomic prediction studies.	Iqbal et al., 2025
Mungbean seedlings	Salinity + ZnO nanoparticles	Seed priming and early growth	Nanoparticles enhanced seedling vigor and stress tolerance	Sherpa et al., 2025
Grain legumes including mungbean	Salt stress	Biostimulant application	Eco-friendly biostimulants improved salinity tolerance	Singh et al., 2025
Mungbean (<i>Vigna radiata</i>) genotypes	Salinity stress	• Germination and antioxidant enzymes • Chlorophyll and ion balance	• Higher antioxidant activity linked with tolerance • Tolerant lines maintained higher chlorophyll stability	Islam et al., 2025
Mungbean accessions (CO4, CO6, VBN2)	Saline irrigation water	Irrigation EC and SAR effects	CO4 performed best under saline irrigation	Kamaleshwaran et al., 2025
<i>Vigna</i> species	Salinity stress	Ionic homeostasis; Physiological and	• Osmolyte accumulation and antioxidants	Suriya et al., 2025

		molecular responses	improved tolerance • Maintenance of K⁺/Na⁺ ratio enhanced tolerance	
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Strategies to Mitigate Salinity Stress: Improved Soil Structure and Crop Production

In this era of climate change, research emphasizes that sustainable management practices such as improved drainage, balanced fertilization, organic amendments, and integrated soil health monitoring are necessary to control increase in saline areas and enhance agricultural resilience in vulnerable Indian regions (Poonia et al., 2024). Together, these recent findings confirm that salinity and sodicity continue to expand in several parts of India, posing long-term risks to soil productivity and food security if not addressed through scientific and region-specific management strategies. Earlier screening studies for salt tolerance in mungbean highlight the importance of germplasm evaluation and selection for developing salinity-resilient cultivars (Sehrawat et al., 2013; Shani et al., 2024). Beside genetic variability, agronomic practices and irrigation management also play key role in mitigating salinity stress. Studies have demonstrated that appropriate combinations of saline irrigation levels and tolerant varieties can improve seed germination and growth performance of crop plants (Kamaleshwaran et al., 2025). Furthermore, modern approaches as pretreatment of seeds or priming, PGPRs, use of osmoprotectants, and advanced biotechnological tools including marker-assisted breeding, transgenics, and genome editing are emerging as promising strategies to enhance salinity tolerance in mung bean (Suriya et al., 2026). However, there remains a need for integrated, field-level validation of these approaches and the identification of robust genotypes capable of sustaining productivity under salt stress. Therefore, further research must be carried out on combine physiological, biochemical, and molecular insights with advanced breeding, genotyping and management strategies to develop resilient mung bean varieties for sustainable farming practices and future nutrition food security (Iqbal et al., 2025).

Integrative Strategies, Management of Salinity Stress for Enhanced Production

Salinity stress management in mungbean involves integrated physiological, biochemical, genetic, microbial, and agronomic approaches that improve plant tolerance and sustain productivity under saline conditions (Figure 2). Recent studies have shown that the use of tolerant crop genotypes is

an efficient strategy for minimizing yield losses under salinity stress (Table 1), as tolerant cultivars maintain better ion homeostasis, antioxidant activity, and osmotic adjustment under high salinity (Islam et al., 2025). Marker-assisted selection (MAS), molecular breeding, speed breeding, genome-wide association studies (GWAS), and gene editing technologies are increasingly being used to identify and transfer salinity-responsive genes related to Na^+ exclusion, K^+ retention, osmolyte accumulation, and stress signaling pathways into elite mungbean cultivars (Jafarullakhan et al., 2024; Sehrawat et al., 2014b; Iqbal et al., 2025).

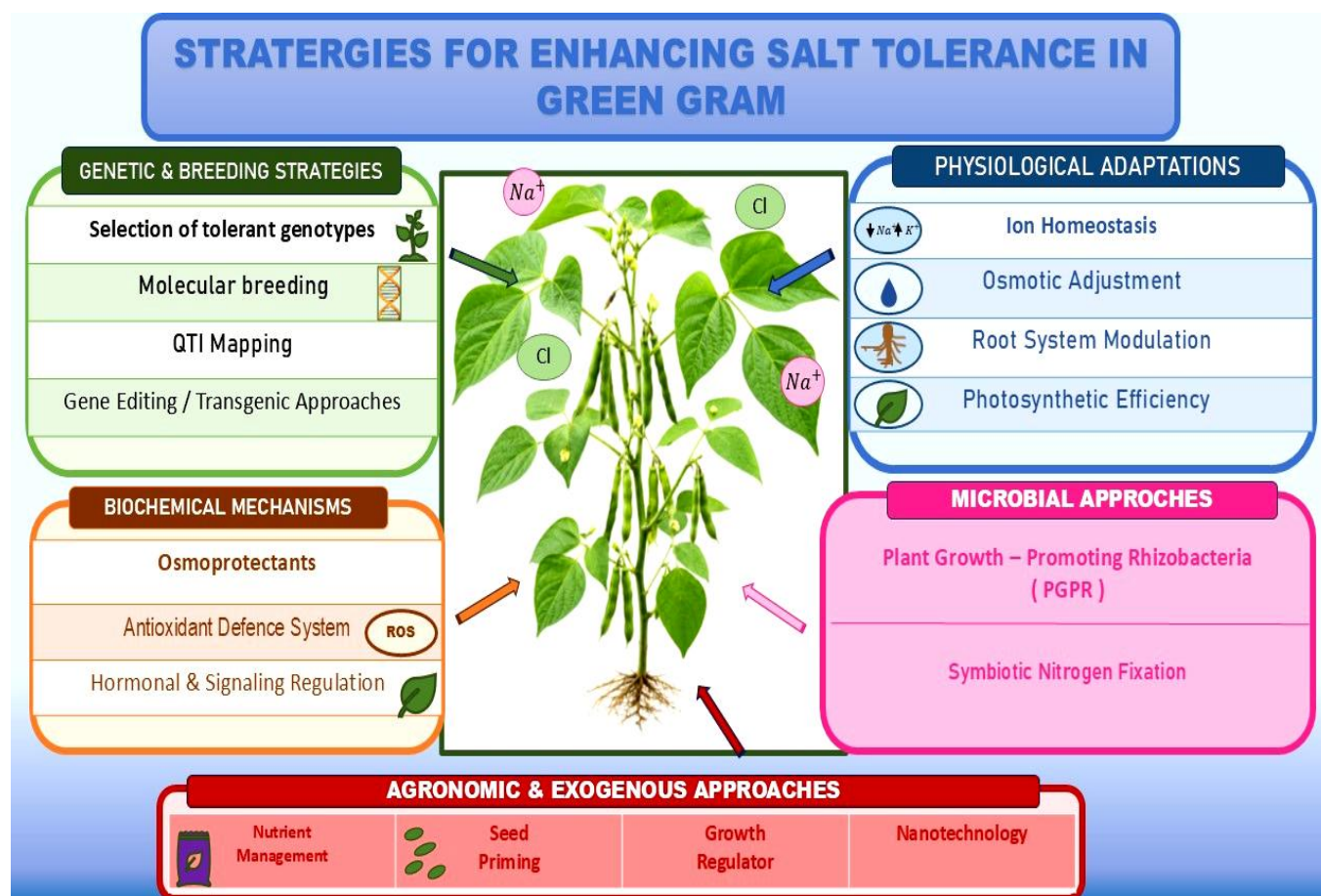


Figure 2: Integrative strategies to develop salinity tolerance in mungbean for sustainable production on saline soil.

Seed priming has emerged as an efficient and low-cost technique for improved germination and seedling growth under saline environments. Priming agents such as proline, polyethylene glycol, salicylic acid, potassium nitrate, and gibberellic acid enhance antioxidant

defense, osmotic regulation, enzyme activation, and membrane stability, thereby improving seedling establishment under salt stress (Chauhan et al., 2023). Nanotechnology-based approaches are also gaining importance, where zinc oxide, silicon dioxide, and titanium dioxide nanoparticles enhance nutrient uptake, chlorophyll synthesis, photosynthetic efficiency, antioxidant activity, and water-use efficiency under saline conditions (Sherpa et al., 2025).

At present, some beneficial microbes and PGPRs have exhibited promising results in reducing salt-induced damage in mungbean by improving nutrient availability, producing phytohormones, increasing root growth, and enhancing antioxidant systems (Bouzroud et al., 2023). Salt-tolerant *Rhizobium* strains improve nodulation and biological nitrogen fixation under saline soils, which enhances plant growth and protein synthesis (Singh et al., 2025). Under salt stress, plants can also preserve cellular osmotic equilibrium and membrane integrity by applying exogenous osmoprotectants such as proline, glycine betaine, and trehalose (Islam et al., 2025).

Potassium is necessary for several plant functions, including membrane integrity, Na^+/K^+ pump regulation, cell homeostasis maintenance, and enzyme activation that controls plant development processes. High potassium levels also improve crop plants' quality and resistance to disease. According to published research, exogenous potassium application reduces the negative effects of salinity on mungbean by causing physio-chemical changes that improve gas exchange parameters, osmolyte production regulation, chlorophyll content, and the K^+/Na^+ ratio, all of which increase plant's performance and productivity. Adverse impacts of salinity are mitigated by potassium (Hasanuzzaman and Fujita, 2022; Shani et al., 2024).

Exogenous GABA (γ -Aminobutyric acid) administration may have increased mungbean plants' tolerance to salinity by preserving their morphology, physio-biochemical processes and lowering buildup of toxic compounds under salt. GABA is a non-protein amino acid having four carbons that are very soluble in water. GABA is quickly accumulated by plants in response to various abiotic stressors. Previous research shown that by encouraging growth and physiological metabolism, the exogenous administration of GABA reduced the harm caused by salinity stress in mungbean plants. It was discovered that GABA was linked to a number of regulations, including: i) decrease in Na^+ ionic content; ii) increase in K^+ , leading to high K^+/Na^+ ratio; iii) enhanced synthesis of pigments involved in photosynthesis; iv) decreased H_2O_2 and MDA content by increasing antioxidant enzymatic activities; v) increase in N concentration and activities of enzymes involved in N-metabolism; and vi) increase in osmolytes production. In

order to better understand the molecular mechanisms by which GABA controls mungbean salt tolerance, future study should concentrate on more in-depth molecular investigations (Ullah et al., 2023).

Nutrient management strategies including supplementation of potassium, calcium, zinc, and silicon help reduce sodium toxicity and maintain ionic balance in plants under saline environments (Jafarullakhan et al., 2024). Improved irrigation management practices as drip irrigation; alternate furrow irrigation, leaching of excess salts, and use of good-quality irrigation water are also effective in minimizing root zone salts accumulation (Singh et al., 2025). Furthermore, foliar applicability of PGRs (brassinosteroids, salicylic acid, abscisic acid, and jasmonic acid enhances stress-responsive pathways, chlorophyll retention, and photosynthesis in mungbean under saline stress (Bouzroud et al., 2023). Integrated use of tolerant varieties, microbial inoculants, seed priming, nanotechnology, and balanced nutrient management is therefore considered efficient sustainable tactic for enhancing salt tolerance and maintaining mungbean productivity under changing climatic conditions (Iqbal et al., 2025; Singh et al., 2025).

Conclusions and Future Perspectives

Mungbean is highly nutritious and significant pulse crop for multiple sectors. Being most nutritious dietary element, particularly in India, mungbean production is hampered due to increasing soil salinity which is a serious threat for agriculture sector in present era of climate change. Integrated use of tolerant varieties, microbial inoculants, seed priming, nanotechnology, and balanced nutrient management is therefore considered as stable as well as sustainable approach for increasing salt tolerance and maintaining mungbean productivity under changing climatic conditions. Present review concludes and suggest that the integration of these approaches, supported by field-level validation and climate-smart agricultural practices, may accelerate developing of salt-tolerant, short duration and high-yielding cultivars of mungbean, thereby ensuring sustainable production, nutritional security, and long-term agricultural resilience towards salinity under changing environmental conditions.

Author Contribution

All authors contributed to the article. AJ., BV., DB, NS prepared the original draft. SK, MY, SKU, NS revised, improved the content and Tables. MY and NS finalized the MS.

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Conflict of Interest

The authors confirm that there is no conflict of interest regarding the publication of this article.

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