

Review Article

A Review on Salt Tolerance and Cultivation Challenges of Jojoba *Simmondsia Chinensis* (Link) Schneider Plant

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Introduction

The woody, perennial, dioecious jojoba (*Simmondsia chinensis* L.), which belongs to the Simmondsiaceae family, is commonly farmed in semi-arid climates. Other names for it include deer nut, coffee berry, wild hazel, and oat nut. The hills of Arizona, southern California, and northwest Mexico are home to the jojoba plant. Over the past thirty years, jojoba has been grown in numerous nations including Saudi Arabia, Egypt, Tunisia, Mexico, Chile, and Argentina [4]. Over 18,500 hectares of jojoba crops are spread across the globe. The oil in jojoba seeds, which has a light gold liquid tint, makes up about 65% of the seeds as shown in (Figure 1) [5]. Several countries grow jojoba, which is thought to be a promising oil crop, for a variety of reasons. Waxy seed oil has been used to cure wounds, relieve headaches, and reduce irritation in the neck due to its anti-in-

Abstract

Jojoba exhibits moderate tolerance to soil salinity. It can withstand salinity levels up to about 8-10 ds/m without significant adverse effects on growth and productivity. However, higher salinity levels can lead to reduced growth rates and lower yields. The main field of study in plant biology have been the reaction of plants to salt stress and the mechanism of salt tolerance. Abiotic stress significantly increases the Methylglyoxal (MG) level of Glyoxalase I (Gly I) gene activity, the first of two enzymes involved in cellular detoxification. Abiotic stress causes large losses to agricultural production globally. The glyoxalase I sequences from the jojoba plant were quickly and simply identified as salt tolerance genes. The glyoxalase I gene was isolated, amplified by PCR using gene-specific primers, and sequenced from the jojoba plant. It was then compared to other glyoxalase I sequences in other organisms [1].

The expression profiles of salt-related genes in the leaf transcriptome of Jojoba (*Simmondsia chinensis*) to decipher the molecular mechanisms underlying salt stress tolerance in this plant species. The analyzed RNA-Seq data identified numerous differentially expressed genes that were mostly upregulated under salt (NaCl) stress conditions. [2].

Alyousif, *et al.* [3] Jojoba seeds were sown on germination media treated with varying doses of seawater up to 2000, 3000, and 5000 ppm of final solute concentration. Salt-tolerant jojoba cultivars were selected and established using in vitro culture. Following selection on germination media with varying solute levels, shoot tips from seedlings were grown on multiple-shoot induction media.

Keywords: *Simmondsia chinensis*; Abiotic stress; Salt tolerant; Methylglyoxal; glyoxalase I.

flammatory, antibacterial, and antifungal qualities. In addition to its medicinal qualities, jojoba seed oil finds extensive application in the cosmetic, bioenergy, and pharmaceutical sectors. Jojoba oil is unique from all other plant-based oils because of its chemical makeup, which is made up of chains of fatty acids and higher alcohols. Jojoba leaves also contain flavonoids, which are antioxidants and can be used to treat cancer, inflammation, and asthma [6]. Farmers who cultivate plants must create effective biotechnology platforms for better cultivation and an enhanced production cycle. Many attempts have been made over the past 20 years to cultivate jojoba in vitro using various molecular biology methods. To achieve good outcomes that aid in resolving cultivation issues, there is still much effort to be done [4].



Figure 1: Jojoba plant cultivated in arid lands.

Salt Tolerance in Jojoba

Salinity levels: One of the most damaging environmental stresses that significantly reduces agricultural output and quality worldwide is salinity. Due to both anthropogenic and natural processes, more than 20% of the world's arable land suffer from the hardship of salt stress, and the number of these regions is steadily rising [11]. However, because of the rising need for irrigation water requirements over the past 20 years, this difficulty has gotten much worse in dry and semi-arid countries [12].

The global environmental issue of salinization of water and soil is particularly problematic in arid and semi-arid regions, where over-irrigation exacerbates the situation [7]. The physiological effects of salinity include growth, oxidative stress, photosynthesis, germination, and water imbalance; these effects can ultimately result in plant death or a reduction in crop yield, biomass, or harvest index. Current irrigation techniques and climate change will probably make this issue worse. To lessen salinity's harmful effects on plants, a variety of tactics have been employed. These include putting in place suitable farm management techniques and choosing or cultivating plant species that can withstand salt [8].

Mechanisms of Tolerance

Physiological adaptations: Plants under salt stress exhibit a range of physiological and metabolic alterations, including delayed seed germination behavior, suppression of other biosynthetic processes, photosynthetic inhibition, and reduced growth. Different crops react differently to salinity; halophytes can grow and reproduce well in saline environments, while glycophytes mostly display growth and a drop in total production. As a result, the accumulation of Na⁺ and Cl⁻ in the leaf has a slower impact at higher osmotic pressures in the root-soil interface. This results in decreased growth of the shoots together with decreased expansion of the leaves and suppression of the establishment of lateral buds. Plant cells can adjust to a low soil water potential by redistributing ions and accumulating suitable solutes in response to salt stress [14]. However, jojoba plants can tolerate salt (Figure 2).



Figure 2: Cultivation of jojoba plant in high salt lands.

Morphological adaptations: As a defense against environmental stressors, plants typically develop secondary metabolites in the wild. The chemical variety of plant-specific metabolic products varies with different stressors. The root system of jojoba can explore deeper soil layers to access less saline water, and the leaves have thick cuticles to reduce water loss and salt uptake [15].

Ion Regulation: Jojoba regulates the uptake and distribution of sodium (Na⁺) and chloride (Cl⁻) ions within its tissues to avoid toxic concentrations, often sequestering these ions in older leaves or vacuoles.

Impact of Salinity

Germination: High salinity can affect seed germination rates. Studies indicate that salinity levels above 4-6 ds/m can significantly reduce germination. The length of the roots and rate of rooting of jojoba plantlets grown at different salinities did not differ significantly, according to Roussos et al. [13]. also revealed comparable outcomes for seedlings raised in a range of salinity conditions, demonstrating that there was no discernible difference in the quantity and length of roots amongst seedlings that germinated and flourished in a variety of salinity conditions. (Figure 3).

Growth: Elevated salinity levels can lead to reduced plant height, leaf area, and biomass. These effects are more pronounced during the early stages of growth.

In vitro salt stress causes jojoba to undergo anatomical changes, including thickness of the mesophyll on leaves and enlargement of the cortex, pith, and xylem vessel diameters on stems. In leaves and stems, cell density dropped; in roots, it rose. the alterations in anatomy brought on by Azospirillum. Brazileense may explain why inoculated plants have a greater tolerance to salinity and shield jojoba plants from the damaging effects of saline stress [9].



Figure 3: Germination of jojoba plant in high salinity lands.

A



B



Figure 4: female a) and male b) plant respectively.

Although *A. brasilense* has been described as tolerant of high NaCl concentrations and is known to promote jojoba rooting, there are no *in vitro* studies of how this bacterium influences jojoba rooting under salt stress. so, inoculation reduces the negative effects of salinity on a clonal group of jojobas [21].

Yield: Salinity stress can reduce the number of flowers and seeds produced, directly impacting yield. Oil content and quality may also be affected under high salinity conditions.

Breeding and Selection: There is ongoing research into developing more salt-tolerant jojoba cultivars through breeding and selection. Identifying and propagating genotypes that naturally exhibit higher tolerance can enhance the sustainability of jojoba cultivation in saline environments. Jojoba is usually propagated from seeds or cuttings. A major problem encountered when propagating from seed is that jojoba is a dioecious plant and its sex is not easily determined prior to flowering (3–4 years from propagation) as shown in (Figure 4,a & b) Vegetative propagation can be achieved by rooting semi-hardwood cuttings or micropropagation. *In vitro* culture allows propagation of plants of known sex and high productivity, and many protocols have been developed to this end using different growth regulators and culture conditions [17-20].

Genetic Improvement: Breeding programs aim to develop jojoba varieties with enhanced salt tolerance, higher yield, and better oil quality. Genetic studies have identified traits associated with stress tolerance that can be targeted in breeding efforts. Therefore, Biotechnological approaches, including genetic engineering and marker-assisted selection, hold promise for accelerating the development of improved jojoba cultivars. Consequently, the glyoxalase I gene was extracted from the jojoba plant, amplified by PCR using gene-specific primers, and sequenced. It was then compared to other glyoxalase I sequences in other plants, such as *Brassica napus*, ID: KT720495.1; *Brassica juncea*. IDs: Y13239.1, DQ989209.2 for *Arachis hypogaea*, and AAL84986 for *A. thaliana* L. [1].

So Jojoba's moderate salt tolerance makes it a viable crop in semi-arid and arid regions where soil salinity can be a challenge. However, effective management of salinity through appropriate agricultural practices and the development of more tolerant cultivars is essential for maximizing the crop's potential and ensuring sustainable production. Because of these traits, jojoba is an attractive crop for arid and semi-arid regions, providing economic benefits while requiring minimal water resources. Its ability to thrive in harsh conditions makes it a sustainable and resilient choice for cultivation in areas prone to salinity

These studies collectively highlight the feasibility of cultivating jojoba in saline environments through both traditional and biotechnological approaches. By leveraging *in vitro* selection and beneficial microbial associations, along with understanding the genetic basis of salt tolerance, researchers are paving the way for more resilient jojoba crops suitable for harsh climates.

Cultivation of jojoba under high salinity: To boost agricultural output and feed the world's expanding population, it is imperative to conduct the required research on salt stress and soil pollution prevention. An increasing number of people are interested in environmentally sustainable salt tolerance strategies as the world's hunger crisis and salinity stress worsen. There are numerous more methods for cultivating crops that can withstand salt besides irrigating with freshwater.

It was effective to choose jojoba plants that could tolerate saline levels of 5000 ppm. However, compared to those chosen Plantlets derived from the 5000-ppm salt level showed less development and multiplication under 2000 ppm and 3000 ppm salinity. The seedlings selected at 2000 and 3000 ppm developed successfully in the multiple-shoot induction and rooting media. The plantlets' high growth and multiplication was not supported by their chlorophyll and carotenoid content, even though, as shown in, the plantlets at 2000 ppm showed higher values in all growth and multiplication parameters during the multiple-shoot induction stage (Figure 5). Conversely, plantlets from 3000 ppm salinity demonstrated high concordance levels of chlorophyll A and carotenoid content, while they performed marginally worse than those from 2000 ppm salinity throughout the multiple-shoot induction stage. Only plantlets that were initially selected at salinities of 3000 ppm and control were able to root in rooting media that had salinities matching those levels. Plantlets picked at varying salt levels have not showed the same development and yield metrics as plantlets coming from the 2000 ppm, despite the latter failing to root. According to the mineral analyses, in plantlets grown in salinity media with 2000 and 3000 ppm, as shown in (Figure 6) the enhanced absorption of Na⁺ did not impact the uptake of K⁺ and Ca²⁺ [3].



Figure 5: Tissue culture of jojoba in various concentration of NaCl.



Figure 6: Rooting of jojoba.

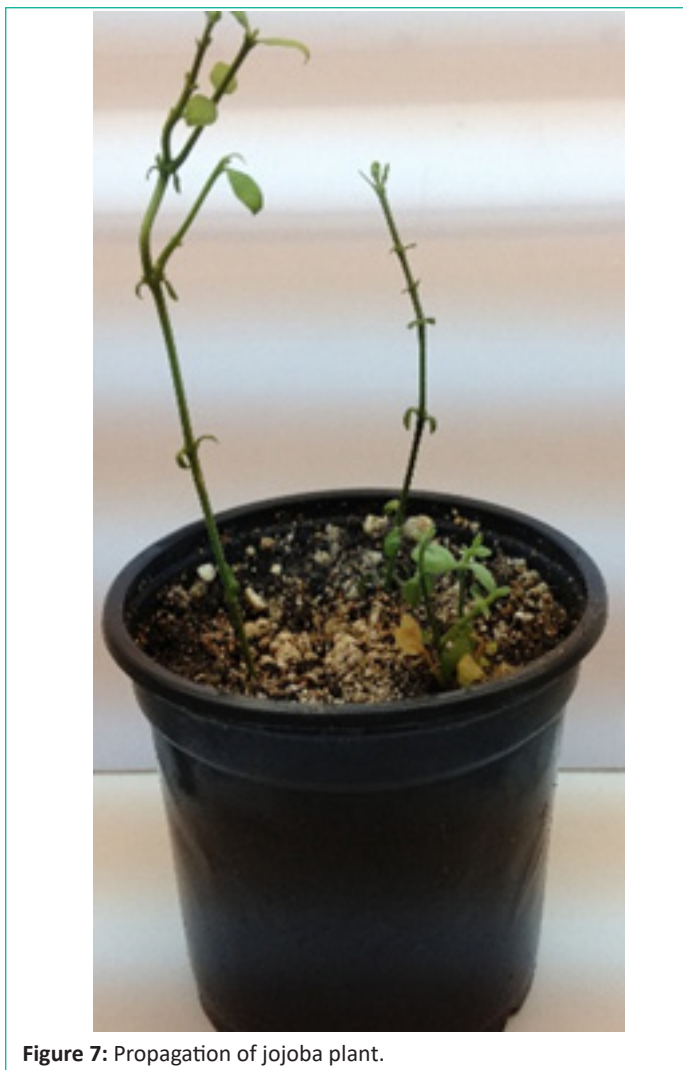


Figure 7: Propagation of jojoba plant.

so that strategy for Future Crop Improvement Jojoba is dioecious in nature, and thus exhibits tremendous variability at clonal level in morphological as well as yield contributing characters. Experiments conducted by various researchers indicate the necessity of selecting desirable male and female plants, and their most compatible combinations, to enhance yields. To ensure further development of jojoba as a commercial crop, it is crucial to identify the factors that contribute to the extreme variability observed in different genotypes. A multidisciplinary approach based on molecular genetics, functional genomics, plant reproductive biology, biochemistry and agronomy may provide accurate information to identify genotypes with stabilized yields in various production systems. The jojoba industry faces the challenge of finding ways to improve productivity and quality of the products [16].

Conclusion

Jojoba's moderate salt tolerance and ability to thrive in arid environments make it a valuable crop for regions with saline soils and limited water resources. Effective soil and water management practices, coupled with ongoing genetic improvement, can mitigate cultivation challenges and enhance the productivity and resilience of jojoba plantations. Research and innovation in agronomic practices and biotechnological interventions are crucial for the sustainable development of jojoba as a commercial crop as shown in (Figure 7).

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