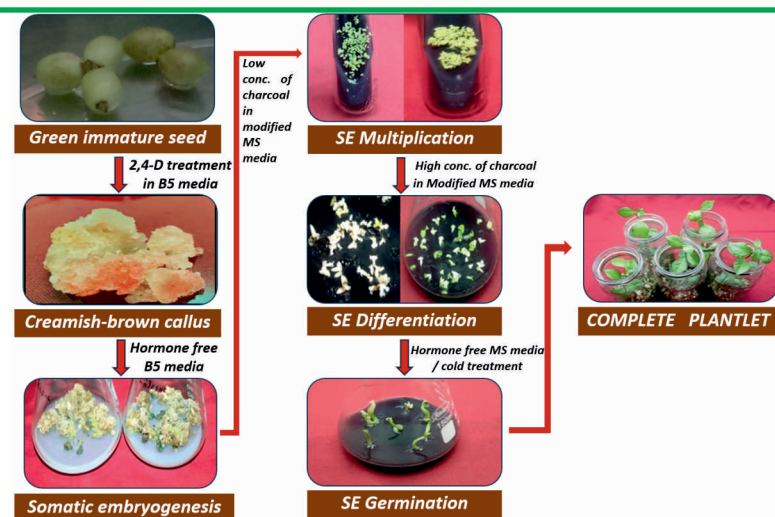




In vitro propagation through cyclic somatic embryogenesis

- ✦ The genetic fidelity of tissue culture-raised plants was confirmed through molecular marker analysis, ensuring they remain true-to-type and uniform for large-scale plantations.
- ✦ Field trials comparing tissue culture-raised and seed-derived plants showed a 100% survival rate for tissue culture plants after seven months, compared to 88% for seedlings, highlighting the initial robustness and adaptability of tissue culture raised plants under field conditions.



Field trial of tissue culture raised Guggul plants

Non destructive gum tapping studies

To ensure sustainable gum harvesting without compromising plant health, non-destructive tapping techniques have been developed. Tapping is recommended on healthy guggul plants aged 8–10 years during March to April. Incisions should be made horizontally at a 60° angle using an increment borer, with a depth of 0.5 to 1.0 cm on the main trunk and primary branches. Each plant can receive 3–4 incisions, with a 10–15 day interval before gum collection. The ideal collection period is from the last week of March to June, allowing 3–5 harvests per



Treatments for enhanced / nondestructive production of gum

plant. Preliminary studies indicated that ethephon, injected at 150–300 mg, effectively induces gum production with minimal injury. Treated cuts healed within a month under arid conditions.

Scalable Guggulsterone Production through Bioreactor

To meet the growing demand for guggulsterone and reduce pressure on wild guggul populations, an efficient guggulsterone-rich cell biomass production system using bioreactor technology has been developed. A suspension culture-



Bioreactor technology for guggulsterone production

based bioreactor enables large-scale and controlled cultivation of guggulsterone-rich biomass with the potential to reduce exploitation pressure on wild populations, if this technology is adopted at a commercial scale. This approach offers a scalable solution for consistent and eco-friendly production. Additionally, a prototype of a Fed-Batch Solid-State Bioreactor has also been developed, and a patent for the innovation is currently pending.

Conclusion

Through these focused and integrated efforts, ICFRE-AFRI is contributing significantly to the long-term sustainability of Guggul by combining conservation with practical cultivation methods. This holistic approach supports the recovery of natural populations and promotes responsible use of the species in arid land farming systems.

Acknowledgement

We gratefully acknowledge the valuable contributions of AFRI Scientists- Dr. Ranjana Arya, Dr. D.K. Mishra, Dr. U.K. Tomar and the team in addition to the authors of this publication, whose pioneering research on *Commiphora wightii* has formed the foundation of the information presented in this pamphlet.



Published by
DIRECTOR

ICFRE-Arid Forest Research Institute
Post – Krishi Mandi, New Pali Road, Jodhpur
Web: <http://afri.icfre.org> email: dir_afri@icfre.org
Phone +91-0291-2722549

Prepared by

Dr. Tarun Kant*, Dr. Anjali Joshi, Dr. Ashok Kumar Parmar

*Email: tarunkant@icfre.org

(Funded by Extension CAMPA 2025-26)

(Designed by Smt. Kusum Lata Parihar, ACTO, Extension Division)



Assessment, Conservation and Propagation of Endangered Medicinal Plant of the Desert -Guggul (*Commiphora wightii*)



ICFRE-ARID FOREST RESEARCH INSTITUTE JODHPUR

INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN
(AN AUTONOMOUS BODY OF MOEF&CC, GOVT. OF INDIA)

Commiphora wightii (Guggul)

Commiphora wightii, or Guggul, is a woody shrub belonging to family Burseraceae and is native to the arid regions of Rajasthan and Gujarat. Adapted to desert conditions, it thrives on rocky soils with minimal water. Recognized by its papery bark, red flowers, and ovoid red fruits, Guggul plays a vital ecological role in dryland ecosystems.



Importance

Considered as a 'Divyaushadhi' in Ayurveda, Guggul is highly valued for its oleo-gum-resin, which is extracted mostly by tapping the main trunk of the plant. This resin has been traditionally used in the incense and perfumery industries and is rich in guggulsterones—bioactive compounds with proven anti-inflammatory, cholesterol-lowering, anti-arthritic and anti-cancerous properties. Used in Ayurveda for centuries and commercially marketed under various names, Guggul oleo-gum-resin holds strong value in herbal and pharmaceutical industries.

Problem

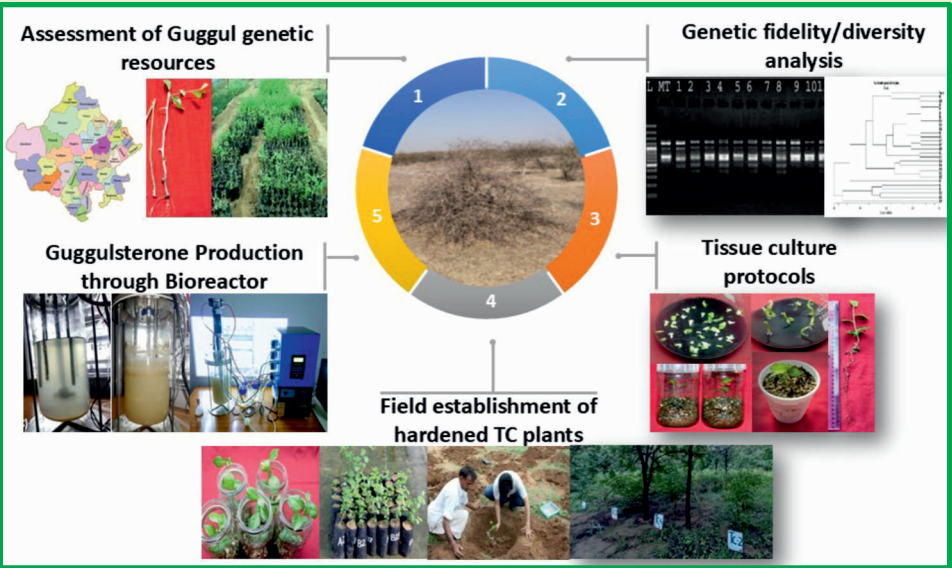
Despite its immense medicinal and economic value, Commiphora wightii is classified as critically endangered by the IUCN (2015). Its natural populations have declined drastically due to unsustainable harvesting practices, habitat destruction, and climate change pressures. Traditional resin tapping methods often cause severe damage or death to mature plants, reducing the number of reproductive individuals in the wild. Natural regeneration is further hampered by several biological constraints, such as:

- Low seed viability and poor germination rates;
- Scarcity of male plants needed for pollination;
- Slow growth, delayed maturity and leafless dead fire wood like appearance

These challenges, coupled with minimal cultivation efforts, have pushed the species to the brink—highlighting the urgent need for scientific intervention, restoration strategies, and sustainable utilization practices.

ICFRE-AFRI's Holistic Approach to Conserve Guggal : From Field to Lab

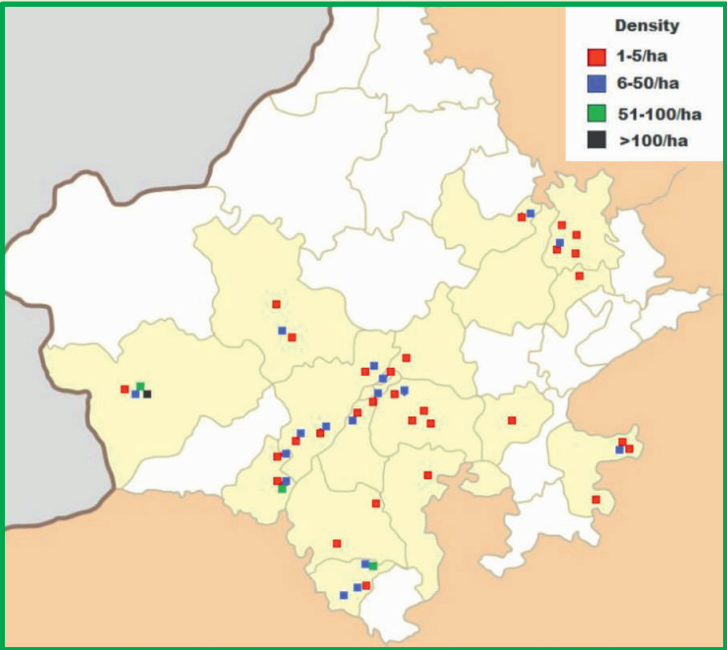
The ICFRE-Arid Forest Research Institute (AFRI), Jodhpur has taken a comprehensive approach to conserve and sustainably utilize Commiphora wightii. Through integrated interventions in genetic resource assessment, propagation, non-destructive resin tapping, and biotechnological innovations involving bioreactor, ICFRE-AFRI has spearheaded significant advancements in Guggul conservation as highlighted in ensuing sections.



Overview of Guggul research at ICFRE-AFRI

Assessment of Guggul genetic resources

A comprehensive survey of guggul populations across 33 districts of Rajasthan revealed Barmer to have the highest plant density (58 plants/ha), although male plants were extremely rare (0.01%), posing a major constraint to natural regeneration. Clonal accessions collected from different regions of Rajasthan showed significant variation, with genotypes from Jaipur and Tonk exhibiting superior growth and form. To support long-term conservation and improvement, a germplasm bank of 104 accessions from Rajasthan has been established and scientifically characterized using DNA marker analysis.



Guggul population density in Rajasthan

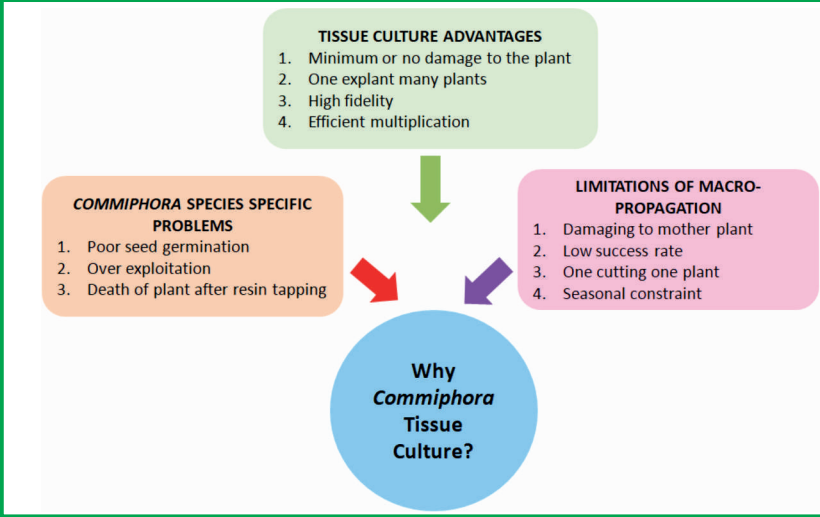
Propagation

- Research revealed three distinct seed color types—off-white, black, and brown. Among these, black seeds exhibited the highest germination rate at 69.3%, making them the most favorable for propagation. Additionally, a water flotation method was used to separate seeds into sinkers and floaters, with sinkers demonstrating superior germination potential, thereby facilitating efficient seed selection.
- Macro-propagation techniques for the species have also been standardized with stem cuttings (>1.5 cm) treated with rooting hormone (Indole butyric acid) under mist chamber conditions showing very high rooting efficiency (95%). Preliminary studies on air-layering also showed 80–90% success in field-level multiplication of mature elite plants. Both these methods offer promising, scalable options for mass propagation of Commiphora wightii.



Rooted stem cuttings of Commiphora wightii

- Micropropagation using cotyledonary nodes and axillary buds was explored with various plant parts, growth regulators, and supplements. Semi-mature stem segments showed the highest success in bud break and shoot initiation. Rooting was efficiently achieved under hormone-free conditions. Remarkably, this method enables rapid, large-scale multiplication of Guggul at an incredibly low cost of just ₹27 per plant.



Need for tissue culture in Guggul

An advanced technique, cyclic somatic embryogenesis, has also been standardized using immature fruits as starting material. This method allows continuous embryo production without the need for fresh explants and supports long-term maintenance of embryogenic calli. It significantly reduces time, labor, and costs, bringing per-plant production cost down to ₹19 per plant.