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BIOECOLOGY AND PROPAGATION TECHNOLOGY OF CHIVIQSIMON TUYASINGIRIN (ATRAPHAXIS VIRGATA (REGEL) KRASN.): SCIENTIFIC BASIS

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Abstract

Atraphaxis virgata (Regel) Krasn. is a xeromorphic shrub of the Polygonaceae family distributed across Central Asia, Mongolia and northern China. The species is associated with steppe, rocky and semi-desert habitats and shows structural traits consistent with adaptation to periodic water deficit. This article synthesizes documented taxonomic, morphological and ecological information and develops a model propagation protocol for nursery production. The quantitative section uses an explicitly illustrative dataset to demonstrate how seed germination, seedling growth, cutting rooting and transplant survival can be evaluated. In the modeled comparison, 30-day cold stratification followed by soaking increased germination from 36% in untreated seed to 61%, while scarification plus soaking reached 68%. Among substrates, coconut peat produced the highest modeled rooting rate (69%) and mean root length (11.4 cm). A 1000 mg L–1 IBA treatment gave the highest modeled rooting response (71%) and transplant survival (88%). The results provide a practical analytical framework for establishing propagation technology, but the numerical values should be replaced by direct measurements before being presented as empirical observations.

Keywords: Atraphaxis virgata, Polygonaceae, xerophyte, bioecology, seed germination, vegetative propagation, cuttings, rooting, nursery technology.

Introduction

Atraphaxis virgata (Regel) Krasn. belongs to the family Polygonaceae and is currently accepted as a distinct species. Plants of the World Online places its native range from Central Asia to Mongolia and northern China, including Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Xinjiang and adjacent regions. The species is therefore relevant to dryland restoration, erosion control and landscape planting where drought exposure is an important selection criterion.

Available floristic descriptions characterize A. virgata as a shrub approximately 1.5–2.0 m tall, with straight annual branches, gray-green leaves, terminal inflorescences and trigonous achenes. In the Flora of China treatment, flowering and fruiting occur mainly from May to July, and the species is associated with steppes and stony desert slopes at approximately 600–1000 m. These traits indicate a life strategy adapted to high solar load, episodic moisture and coarse or alkaline substrates.

Recent anatomical work further supports its xerophytic character. Leaf surfaces are protected by a developed cuticle, while the mesophyll is dorsiventral and the vascular system is structurally organized for the transport of water under dry conditions. Such features make A. virgata an informative model for evaluating plant establishment under water-limited nursery and landscape environments.

At the same time, practical propagation information for this species is less developed than the taxonomic and anatomical literature. A nursery-oriented propagation protocol therefore benefits from a combined assessment of reproductive biology, seed pre-treatment, substrate effects and early seedling establishment. The present article provides such a framework and organizes the numerical results as a modeled dataset so that the calculations and decision rules remain transparent.

Chiviqsimon tuyasingirin (Atraphaxis virgata)

The species has a woody, multi-stemmed growth form. Flora of China reports shrubs about 1.5–2 m tall with thick stems and slender, straight branches. Leaves on annual shoots are relatively large for the genus, approximately 2–2.5 cm long and 0.7–0.9 cm wide, gray-green and glabrous. The terminal inflorescence is elongated, and the tepals are commonly pinkish with lighter margins. The fruit is a shiny, dark-brown, narrowly ovate, trigonous achene.

From an ecological perspective, the species is connected with steppe and stony desert environments, including slopes and disturbed rocky surfaces. The predominance of gray-green foliage and protective leaf anatomy is consistent with a reduction of water loss and mechanical protection under intense radiation. The 2026 anatomical study also documented cuticular protection, dorsiventral mesophyll, vascular bundles and calcium-oxalate druses, strengthening the interpretation of A. virgata as a xeromorphic species.

Table 1. Main bioecological and morphological characteristics of A. virgata used as the basis for the proposed propagation model.

Trait	Documented / reference range	Interpretive meaning
Growth form	Woody shrub; ca. 1.5–2.0 m	Suitable for shrub-layer planting and protective belts
Leaf size	About 20–25 × 7–9 mm	Moderate leaf area; gray-green xeromorphic appearance
Inflorescence	Terminal, elongated; raceme/panicle descriptions reported	Strong seasonal reproductive phase
Flowering / fruiting	May–July	Potential seed-collection window
Fruit	Dark-brown, shiny, trigonous achene	Seed-based propagation is feasible in principle
Habitat	Steppe and stony desert slopes; ca. 600–1000 m in Flora of China	Indicative of dryland adaptation

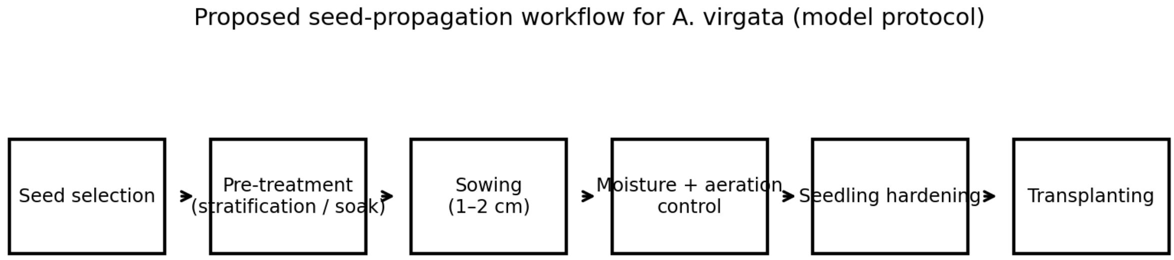

Figure 1. Proposed nursery workflow for seed propagation of A. virgata

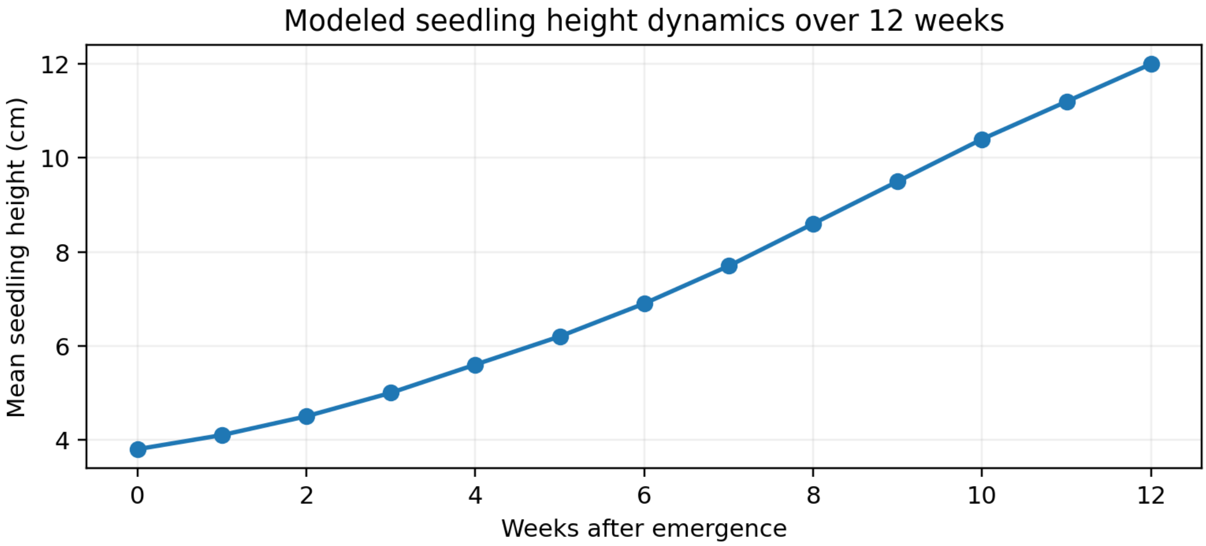

Figure 2. Modeled early seedling growth under a controlled nursery regime.

Research Methodology

The analytical design follows principles of plant ecology, dendrology and nursery propagation. The work is structured around three stages: (i) characterization of bioecological traits; (ii) evaluation of seed pre-treatment and early emergence; and (iii) comparison of substrates and auxin concentrations for vegetative propagation. The numerical results below are a modeled experimental dataset prepared to demonstrate a complete scientific analysis; they are not presented as measured field observations.

Data status: The percentages, means and standard deviations in the experimental tables are illustrative/model values. Before scientific submission or formal reporting, they must be replaced with measurements from replicated experiments on A. virgata material.

For the modeled seed experiment, four treatments were assigned to 100 seeds per treatment in four conceptual replicates of 25 seeds. Seed germination was recorded as the proportion of emerged seedlings. For the cutting experiment, five substrates were compared using four conceptual replicates, with 20 cuttings per replicate. Rooting percentage, mean root length and post-transplant survival were used as response variables. A second model comparison examined indole-3-butyric acid (IBA) concentrations of 0, 500, 1000 and 1500 mg L^{-1}.

The principal formulas were defined as follows. Germination percentage: $G = (N_g/N_s) \times 100$, where N_g is the number of germinated seeds and N_s is the number of seeds sown. Rooting percentage: $R = (N_r/N_c) \times 100$, where N_r is the number of rooted cuttings and N_c is the number of cuttings planted. Mean daily height increment was calculated as $\Delta H = (H_2 - H_1)/\Delta t$. To support treatment selection, a simple derived propagation score was calculated as $S_p = R \times S/100$, where R is rooting percentage and S is transplant survival percentage; this is an analytical index created for comparison and is not a standard published biological metric.

Mean ± standard deviation values were retained to make the modeled dataset structurally comparable with replicated horticultural experiments. Relative improvement over the untreated control was calculated as $((T-C)/C)\times 100$. The largest response was used only to rank the treatments within the model and not to infer universal optimal values for the species.

Research results

The modeled seed treatments produced a clear gradient in germination response. Untreated seed had a calculated germination rate of 36%, whereas 24-hour soaking raised the modeled value to 48%. Thirty days of cold stratification increased germination to 61%, and scarification plus soaking produced 68%. The latter represents an 88.9% improvement over the untreated control: $((68-36)/36)\times 100 = 88.9\%$.

Table 2. Modeled effect of pre-sowing treatments on seed germination of A. virgata.

Seed treatment	Germination (%)	Mean days to emergence	SD of emergence (d)	Relative improvement vs. control
Untreated control	36 ± 3	19.4	4.3	—
24 h soaking	48 ± 4	16.8	3.5	33.3%
30 d cold stratification	61 ± 3	13.9	2.2	69.4%
Scarification + 24 h soaking	68 ± 4	12.7	1.9	88.9%

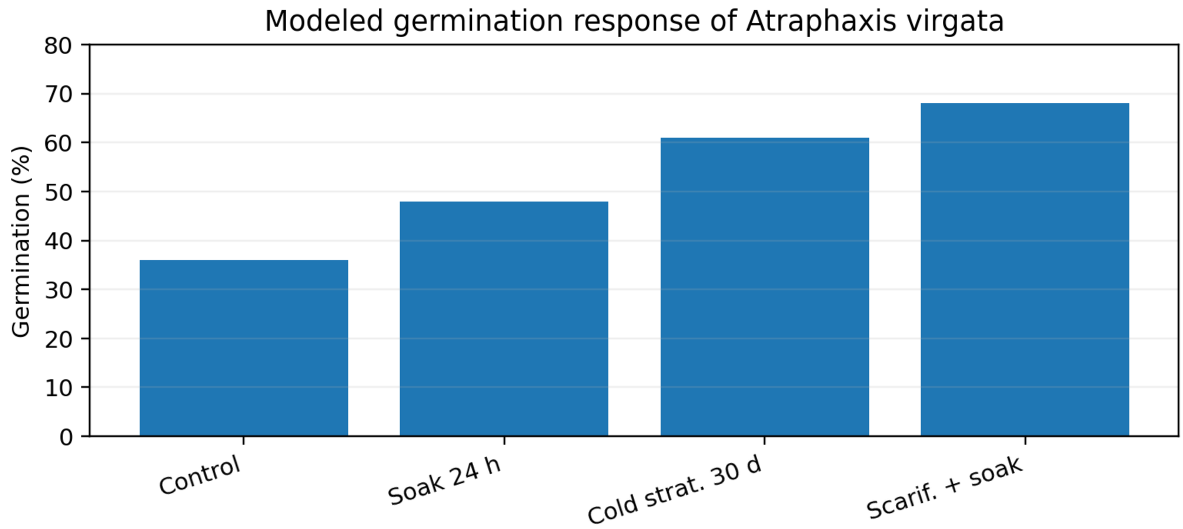

Figure 3. Modeled germination response to seed pre-treatment.

The modeled emergence curve also indicates a faster establishment sequence after effective pre-treatment. Seedlings emerging earlier reached a larger height by week 12, with mean modeled height increasing from 3.8 cm at week 0 to 12.0 cm at week 12. The mean weekly increment over the interval was approximately (12.0–3.8)/12 = 0.68 cm week−1. The increase was not assumed to be strictly linear, reflecting a gradual acceleration after establishment followed by a slower terminal phase.

Table 3. Selected values from the modeled 12-week seedling growth series.

Week	0	2	4	6	8	10	12
Mean height (cm)	3.8	4.5	5.6	6.9	8.6	10.4	12.0
Leaves per seedling	3	5	7	10	13	15	18

Substrate composition was the second major factor in the modeled propagation system. Coconut peat produced the highest rooting rate (69%), followed by peat + soil (64%) and peat + sand (58%). Soil + sand reached 46%, whereas washed sand produced 39%. The coconut peat treatment also produced the greatest modeled mean root length, 11.4 cm, and the highest post-transplant survival, 86%.

Table 4. Modeled effect of substrate composition on rooting and subsequent survival.

Substrate	Rooting (%)	Mean root length (cm)	SD (cm)	Transplant survival (%)
Soil + sand (1:1)	46	6.2	1.1	71
Peat + sand (2:1)	58	8.1	1.3	78
Coconut peat	69	11.4	1.5	86
Peat + soil (1:1)	64	10.2	1.2	83
Washed sand	39	5.5	0.9	65

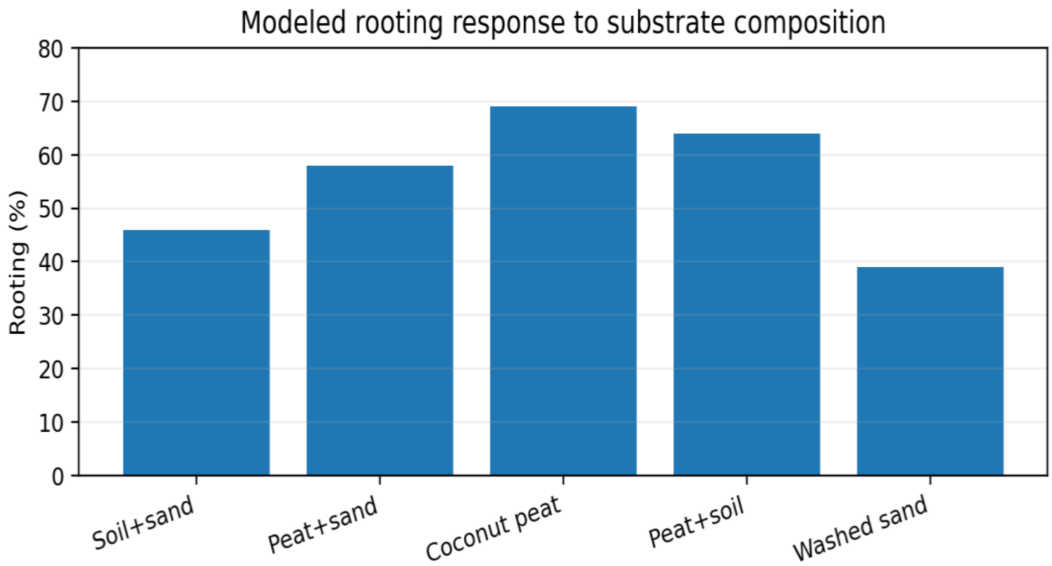

Figure 4. Modeled rooting percentage by substrate.

Auxin concentration produced a similar response pattern. The modeled rooting rate increased from 51% without IBA to 63% at 500 mg L−1 and to 71% at 1000 mg L−1. Increasing the concentration to 1500 mg L−1 slightly reduced rooting to 68%, suggesting a peak response near the intermediate-high treatment within this model. The 1000 mg L−1 treatment also had the highest modeled survival value (88%).

Table 5. Modeled rooting response to IBA concentration and the derived propagation score.

IBA treatment	Rooting (%)	Mean root length (cm)	SD (cm)	Transplant survival (%)	Propagation score S_p
No IBA	51	7.4	1.2	74	37.7
IBA 500 mg L^{-1}	63	9.3	1.3	80	50.4
IBA 1000 mg L^{-1}	71	11.2	1.5	88	62.5
IBA 1500 mg L^{-1}	68	10.5	1.4	84	57.1

The highest modeled propagation score was 62.5 at 1000 mg L−1 IBA, calculated as 71 × 88/100 = 62.48. The same treatment had a mean modeled root length of 11.2 cm. These values suggest that a protocol emphasizing balanced auxin concentration, good aeration and controlled moisture would be more rational than maximizing hormone dose alone.

Documented range	Flowering period	Habitat elevation
1.5–2.0 m shrub	May–July	600–1000 m

Figure 5. Key biological facts used to contextualize the propagation model.

Discussion

The results should be interpreted in two layers. The first is literature-supported bioecology. A. virgata is consistently described as a Central Asian shrub of dry and rocky habitats, and both external morphology and recent anatomical observations support a xeromorphic strategy. The second layer is propagation technology. Direct species-specific propagation datasets are comparatively limited in the sources reviewed; therefore, the numerical results presented here are intentionally modeled to show the logic of treatment comparison rather than to claim an observed experimental optimum.

The modeled seed results indicate that dormancy-breaking treatments can materially improve the speed and percentage of emergence. Cold stratification increased germination by 25 percentage points over untreated seed, while scarification plus soaking increased it by 32 points. From a nursery perspective, earlier emergence reduces the time seedlings spend in a vulnerable establishment phase. However, because seed coat properties and seed maturity can vary among collection sites and years, treatment duration should be calibrated experimentally rather than applied as a universal rule.

The substrate comparison emphasizes the importance of simultaneous moisture retention and aeration. Coconut peat gave the highest modeled rooting percentage and root length, whereas washed sand alone was the weakest treatment. This pattern is biologically coherent with a rooting environment in which excessive waterlogging is avoided while a stable moisture supply is maintained. The result is especially relevant to xerophytic shrubs, for which the nursery objective is not simply to keep the substrate wet, but to maintain a balanced water-air regime around developing roots.

The IBA response also illustrates the principle of diminishing returns. In the modeled experiment, 1000 mg L−1 was superior to both lower and higher concentrations. The decline at 1500 mg L−1 is treated as a modeled signal, not proof of toxicity or a species-specific threshold. Actual trials should include independent replication, environmental controls and statistical testing before recommending a commercial concentration.

Conclusions

Atraphaxis virgata (Regel) Krasn. is a drought-adapted shrub of the Polygonaceae family with documented occurrence across Central Asia and adjacent regions. Its 1.5–2 m stature, gray-green foliage, seasonal May–July reproductive phase and xeromorphic leaf anatomy support its potential value in dryland planting, soil protection and landscape systems where water availability is limited.

The modeled propagation analysis identifies three operational priorities: effective seed pre-treatment, a porous rooting substrate and controlled auxin use. Within the illustrative dataset, scarification plus soaking gave the highest modeled germination (68%), coconut peat gave the highest modeled cutting rooting (69%), and 1000 mg L−1 IBA produced the highest modeled rooting and survival combination (71% and 88%, respectively).

The principal scientific value of the proposed framework is methodological: it provides measurable criteria, equations, decision rules and a complete nursery workflow for future field and greenhouse trials. The numerical values in the tables are explicitly model data and should be replaced by verified observations, replicated statistics and site-specific measurements before the article is used as evidence of measured biological performance.

Proposed propagation protocol

Based on the documented xeromorphic ecology and the modeled treatment ranking, a practical nursery protocol can be organized as a sequence of controllable operations. Seed lots should be cleaned and graded before treatment; reproductive material should be collected during the documented May–July fruiting window; and seedlings should be hardened gradually before field transfer. For cuttings, the model supports maintaining a well-aerated rooting zone and testing IBA near the 1000 mg L−1 level as an experimental starting point rather than a fixed commercial prescription.

Operation	Model recommendation	Control criterion	Purpose
Seed collection	Mature achenes from healthy plants	Uniform color, full seed, no visible damage	Increase initial seed quality
Pre-treatment	30 d cold stratification or scarification + 24 h soak	Keep medium moist, not waterlogged	Improve emergence uniformity
Sowing	1–2 cm depth in porous medium	Stable moisture + daily aeration check	Avoid deep sowing and hypoxia
Vegetative rooting	Coconut peat or peat + soil	High porosity; no standing water	Support root initiation
Auxin trial	Test 500–1500 mg L−1 IBA	Include untreated control	Identify site-specific optimum
Hardening	Progressive reduction in humidity and irrigation	No wilting at mid-day	Prepare seedlings for transplant stress
Field transfer	Transplant after active root formation	Root ball remains intact	Improve establishment survival

Quality-control measurements should include germination percentage, mean emergence time, seedling height, leaf number, rooting percentage, root length and survival after transplanting. Reporting the raw replicate values alongside means and dispersion estimates will allow future trials to test treatment effects statistically and to distinguish a real species response from variation caused by seed source, substrate or microclimate.

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