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TECHNOLOGY FOR PRODUCING HEALTHY PLANTING MATERIAL OF PROMISING GRAPEVINE CULTIVARS THROUGH IN VITRO BIOTIZATION AND BIOLOGICAL PROTECTION IN THE FERGANA VALLEY

Akramova Mahliyo Botırali qizi

Abstract. This paper develops a literature-based technological framework for producing pathogen-tested grapevine (Vitis vinifera L.) plantlets adapted to the agroecological conditions of the Fergana Valley, Uzbekistan. The proposed workflow integrates mother-vine selection, in vitro shoot-tip culture, targeted pathogen indexing, rooting, ex vitro biotization and biological protection during nursery acclimatization. Particular attention is given to the compatibility of arbuscular mycorrhizal fungi (AMF), selected Trichoderma strains and beneficial bacteria, as well as to nursery sanitation and heat-stress management. A comparative treatment design and illustrative survival-rate chart are presented to guide future validation; these numerical values are hypothetical, not results of a conducted field experiment.

Keywords: grapevine; Fergana Valley; micropropagation; in vitro culture; biotization; arbuscular mycorrhiza; Trichoderma; biological control; acclimatization.

INTRODUCTION

Viticulture is an important horticultural activity in the Fergana Valley, where hot summers, variable irrigation availability and localized salinity can increase transplant stress. The establishment of productive vineyards depends on genetically authentic, vigorous and phytosanitarily verified planting stock. Traditional vegetative propagation can transfer systemic viruses and other pathogens from infected mother vines; sterile culture alone does not guarantee virus-free status. Therefore, micropropagation must be integrated with laboratory indexing and systematic certification procedures rather than presented as a substitute for disease testing (Kumsa, 2020; Gutiérrez-Gamboa et al., 2023).

In vitro multiplication can generate uniform plantlets at scale, yet the passage from nutrient-rich, humid vessels to nursery conditions is often a bottleneck because young plantlets have weak cuticles, altered stomatal function and immature roots (Grzelak et al., 2024). Biotization refers to the deliberate establishment of compatible beneficial microorganisms on plantlets, normally during rooting or ex vitro acclimatization, to support root function and resilience. The objective of this thesis is to outline a feasible protocol for Fergana Valley grape nurseries and propose measurable indicators for its evaluation.

MAIN PART

1. Selection and sanitation of starting material. Candidate locally adapted and commercially promising cultivars should be selected according to fruit quality, market demand and tolerance to abiotic stress. Each source vine must be assigned an accession code and inspected for disease symptoms; molecular assays (e.g., RT-PCR/ELISA for priority viruses) should be conducted within an accredited diagnostic framework. Shoot-tip or meristem culture may reduce pathogen loads, but negative

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test results before and after multiplication are necessary to substantiate sanitary claims. Identity should be periodically checked against reference plants to minimize off-types and somaclonal variation (Gutiérrez-Gamboa et al., 2023; Kumsa, 2020).

2. Establishment, multiplication and rooting. Juvenile shoot tips or nodal segments are surface-disinfected and initiated on an appropriate basal medium such as Murashige–Skoog medium. Cytokinin and auxin combinations should be optimized separately for each genotype because shoot proliferation, hyperhydricity and rooting vary among cultivars. Repeated subculturing should be limited and documented. Plantlets with formed roots, healthy leaves and no visual contamination are transferred to a porous, disinfected acclimatization substrate; excessive waterlogging must be avoided (Murashige & Skoog, 1962; Kumsa, 2020; Gutiérrez-Gamboa et al., 2023).

3. Biotization and biological protection. Beneficial arbuscular mycorrhizal fungi can enhance nutrient acquisition and plantlet establishment during acclimatization, although outcomes depend on fungal isolate, rootstock genotype and substrate conditions (Krishna et al., 2005). Selected, quality-controlled Trichoderma spp. may suppress particular nursery-associated fungi via competition or antagonism; however, strain-specific greenhouse and field efficacy cannot be assumed from petri-dish assays alone (Mesguida et al., 2023). Bacillus-based agents are another candidate, but product registration, compatibility with mycorrhiza, inoculation timing and phytotoxicity need validation. Beneficial microbes should not be introduced into sterile multiplication vessels indiscriminately, where they can destroy axenic cultures.

4. Acclimatization in Fergana conditions. Plantlets should first be hardened under filtered light, high but gradually declining relative humidity and carefully controlled root-zone moisture. Subsequently, shade and humidity are reduced stepwise, ventilation is increased and irrigation adjusted to substrate water-holding capacity. Before open-field transfer, seedlings should be assessed for active root growth, stem lignification, absence of disease and stable water balance. Irrigation-water salinity and summer heat require routine monitoring (Grzelak et al., 2024; Kara et al., 2022).

Table 1. Proposed nursery treatment scheme and primary assessment indicators.

Treatment	Biological intervention	Evaluation metrics
T0: control	Standard ex vitro hardening only	Survival; root number; height
T1: AMF	Verified AMF inoculum at potting	Root colonization; P uptake; survival
T2: Trichoderma	Registered, validated antagonist	Fungal disease incidence; survival
T3: integrated	AMF + compatible biocontrol strain	Survival; biomass; disease index

To test efficacy, a randomized block experiment should include each treatment in at least three independent blocks and an explicitly reported number of plants per block. Survival (%) = (living plants / initially transferred plants) × 100. Measure survival at

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30 and 60 days, root length, leaf area, dry biomass, pathogen incidence and microbial colonization; analyze cultivar × treatment effects with an appropriate model and multiple-comparison adjustment. Any treatment advantage should be assessed together with propagation cost and compliance with phytosanitary standards.

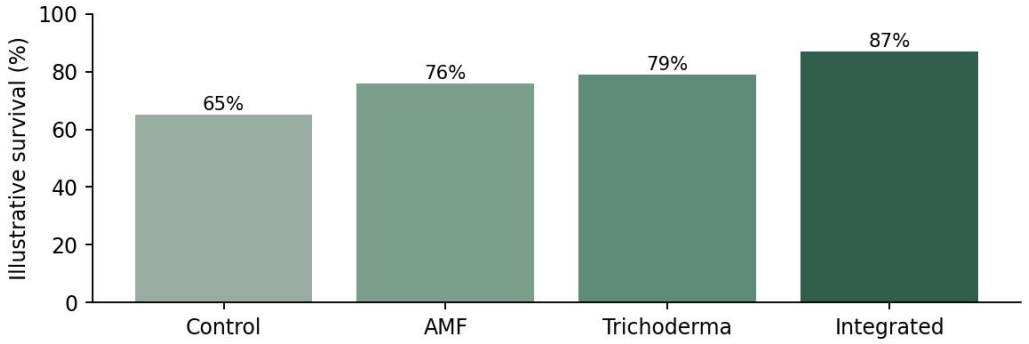


Figure 1. Hypothetical survival values used solely to illustrate a future experimental comparison; NOT observed data.

For example, the illustrative chart assumes 65% survival in untreated nursery controls and 87% in integrated biotization. These numbers represent a planning scenario only; they do not demonstrate efficacy in Fergana. The proposed integrated system should be accepted for production only after cultivar-specific replication, pathogen indexing, assessment of field establishment and economic evaluation.

CONCLUSION

A promising strategy for producing high-quality grapevine seedlings in the Fergana Valley is a staged system combining verified mother plants, genotype-adapted in vitro micropropagation, repeated phytosanitary testing, controlled hardening and carefully validated microbial biotization. AMF and strain-specific biocontrol agents may complement—not replace—hygiene, diagnostics and nursery management. Local replicated trials are necessary to determine the optimal inoculant combination, hardening regime, transplant survival and cost effectiveness before issuing production recommendations.

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