Volume 3, Issue 10, October - 2025 **ISSN (E):** 2938-3811

CONDITIONS FOR ENHANCING THE ROOTING PROCESS OF REGENERANTS UNDER THE INFLUENCE OF ENDOGENOUS STIMULATORS

Xalilova Sevara Abdumannobovna
Xaydarova Ra'no Anorboyevna
Sharof Rashidov Samarkand State University,
Academic Lyceum of Samarkand State University
Email: sevara.khalilova.88@mail.ru
xaydarovarano1803@gmail.com

Abstract
This study investigated the effect of nutrient media supplemented with BERES UNIVERSAL fertilizer and the phytohormone IAA1 on accelerating and enhancing the efficiency of root formation in Capparis spinosa L. regenerants.

Keywords: Capparis spinosa L., microclonal propagation, rooting, BERES UNIVERSAL, endogenous stimulators, IAA1

Introduction

Capparis spinosa L. is one of the medicinal plants rich in bioactive compounds, traditionally used in folk medicine and highly valued in the modern pharmaceutical industry. This species predominantly grows in arid and rocky regions and exhibits a low rate of vegetative propagation. Extensive harvesting of its natural populations for raw materials can seriously damage ecosystems and lead to a decline in biodiversity. Therefore, developing sustainable and environmentally safe methods for propagating Capparis spinosa L. and ensuring a stable supply of medicinal raw materials has become a pressing scientific and practical issue [1].

In recent years, the Republic of Uzbekistan has adopted several important legislative acts aimed at restoring medicinal plant resources, cultivating them under controlled conditions, processing, and ensuring the rational use of biological resources. For instance, the Presidential Decree No. PQ-2595 dated September 16, 2016, outlines the tasks for further developing the national pharmaceutical industry in 2016–2020, including the production of high value-added pharmaceutical products and the cultivation of their raw materials. Furthermore, Resolution No. 991-F of the Cabinet of Ministers of the Republic of Uzbekistan, issued on September 3, 2017, set forth the establishment, cultivation, and export of Capparis spinosa L. plantations [6]. These legal frameworks, together with the increasing national and international demand for medicinal plants, underscore the practical relevance of this research. Accordingly, the in vitro microclonal propagation of Capparis spinosa L. represents a promising solution for producing

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sustainable, reproducible, and environmentally safe medicinal raw materials, supporting the national pharmaceutical industry, and conserving natural resources [4].

Optimization of microclonal propagation conditions and reduction of rooting time are among the key directions in modern plant biotechnology. Such methods are particularly valuable for the rapid and high-quality propagation of rare, endangered, and agriculturally important plant species. The main challenges in micropropagation include the low rooting rate of shoots and the slow pace of root initiation. This problem can be effectively addressed through the use of endogenous stimulators—either naturally produced within plants or externally supplemented—including humic and fulvic acids and phytohormones [2,3].

These stimulators activate cell division, enhance mitotic activity, and accelerate physiological processes within the plant organism, including the differentiation of root tissues. The BERES UNIVERSAL fertilizer can serve as an effective agent for stimulating root formation in microclonal propagation systems. It contains humic and fulvic acids derived from peat and coal, which enhance plant respiration, improve nutrient uptake, accelerate root initiation, promote root branching, and increase metabolic activity due to their low molecular weight and high cell permeability. Moreover, they strengthen plant stress resistance and exert a hormone-like effect that promotes rooting.

The application of BERES UNIVERSAL fertilizers in microclonal propagation is a promising approach to enhance root formation capacity, accelerate regeneration, and improve overall propagation efficiency. Its natural endogenous stimulators create a balanced physiological environment within the plant organism, which is of significant scientific and practical importance [5].

In this study, the inclusion of BERES UNIVERSAL in the nutrient medium during the microclonal propagation of Capparis spinosa L. resulted in root formation within 55–60 days (Table 1; Figures 1–2).

Table 1. Effect of Duration on Root Formation Parameters

Nutrient Medium	Duration (days)	Rooted Shoots (%)	Mean Root Number	Mean Root Length (cm)
GM	75	68±3,6	2,5±0,5	2,4±0,4
MS+BERES UNIVERSAL	55	73±3,1	3,7±0,2	2,7±0,3
MS IAA1+BERES universal	50	78±3,1	4,1±0,4	3,0±0,3

The table demonstrates the effect of different nutrient media—GM, MS + BERES UNIVERSAL, and MS + IAA1 + BERES UNIVERSAL—on the percentage of rooted shoots, average root number, and average root length.

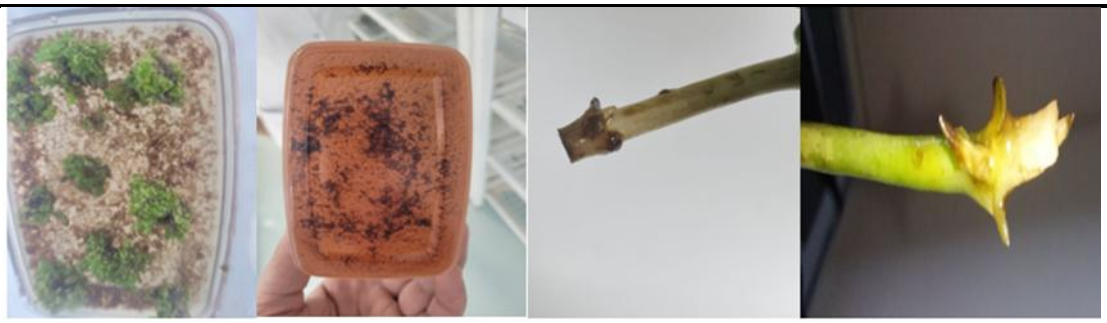

Figure **1.** Effect of the endogenous stimulator BERES UNIVERSAL on the rooting of Capparis spinosa L.

Under standard GM (control) medium conditions, the rooting period was the longest (75 days), and the parameters were comparatively lower. The MS + BERES UNIVERSAL medium significantly accelerated root formation and improved the results. The combination of MS + IAA1 + BERES UNIVERSAL produced the best outcomes, with the highest rooting percentage (78%), greater root number (4.1 per shoot), longer roots (3.0 cm), and the shortest rooting period (50 days). These results demonstrate that supplementation with BERES UNIVERSAL, particularly in combination with IAA1 (indole-3-acetic acid), effectively accelerates the rooting process and enhances propagation efficiency.

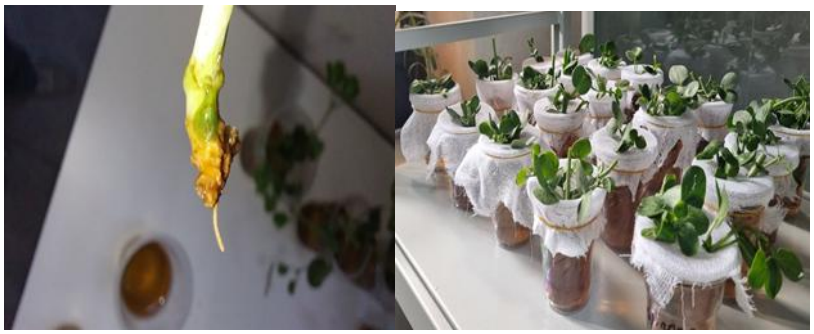

Figure 2. Root formation of Capparis spinosa L. under the influence of the endogenous stimulator BERES UNIVERSAL.

Research on optimizing microclonal propagation conditions and accelerating root formation has shown that BERES UNIVERSAL fertilizer, especially when combined with phytohormones such as IAA1, significantly increases the rooting efficiency of explants. The humic and fulvic acids, along with macro- and microelements in the preparation, promote cell division, support root tissue differentiation, and maintain physiological balance within the plant organism.

Conclusion

According to the data presented in Table 1, compared with the standard GM medium, the rooting period in MS + BERES UNIVERSAL and particularly in MS + IAA1 + BERES UNIVERSAL media decreased by up to 25 days. The percentage of rooted shoots, as well as root number and length, also increased significantly. These findings confirm the scientific and practical promise of applying BERES UNIVERSAL fertilizer in microclonal propagation systems.

Therefore, the use of BERES UNIVERSAL nutrient medium is recommended as an effective approach in microclonal propagation technologies to accelerate regeneration processes, enhance root formation parameters, and improve the overall propagation efficiency of plants.

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