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Effectiveness of Various Stimulators on the Rhizogenesis of *Vinca* L. Species Cuttings

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Abstract

Rooting of stem cuttings is the main practical route for propagating *Vinca* L. species, but root formation is often slow. This study compared three commercial rooting stimulators (Gumi-Mix, Kornevin and Rootex Gold) with a distilled-water control on cuttings of *Vinca major* L. and *Vinca minor* L. in the Samarkand region of Uzbekistan. Cuttings were soaked for 3, 6 or 12 h, planted in sand and monitored for 60 days, and the number of rooted cuttings, the number of roots per cutting and root length were recorded; each species-solution-soaking-duration group comprised 50 cuttings. In *V. major*, 6 h soaking in Gumi-Mix gave the highest rooting (49 of 50 cuttings, 98%) compared with 42 of 50 (84%) in the best control group, with 7 vs 2 roots per cutting and root lengths of 4.9 vs 1.5 cm. In *V. minor*, rooting percentages were similar for Gumi-Mix and Kornevin (pooled 89.3% and 92.7%), whereas Gumi-Mix was associated with earlier root initiation (7 - 9 vs 9 - 12 days in the control), more roots and longer roots; Rootex Gold gave no increase in rooting over the control. The comparisons are descriptive, and the conclusions apply only to the tested conditions.

Keywords

Vinca major, *Vinca minor*, Rhizogenesis, Stem Cuttings, Rooting Stimulators, Gumi-Mix, Kornevin, Rootex Gold

1. Introduction

Research on the propagation of ornamental plants, on their bioecological characteristics and on propagation technologies has expanded worldwide in recent years. Plant species that combine medicinal and ornamental value are of particular interest. One such group is the genus *Vinca* L. (Apocynaceae), which comprises approximately 7 - 12 species distributed across Europe, Asia and the Mediterranean

region. *Vinca major* L. and *Vinca minor* L. are widely distributed and have been introduced into the flora of Uzbekistan in recent years.

Greater periwinkle (*V. major*) is an evergreen perennial that is cultivated in many regions for decorative and medicinal purposes. It contains alkaloids and flavonoids and is therefore of interest to the pharmaceutical industry [1].

Lesser periwinkle (*V. minor*) is a creeping perennial that is valued both as a ground cover and as a medicinal plant. Its characteristic alkaloid is the indole alkaloid vincamine, and the alkaloids of the genus *Vinca* (more than 200 have been identified) show a range of reported biological activities, including antitumor, anti-Alzheimer, antibacterial and antihypertensive effects [2]. The anticancer bisindole alkaloids vinblastine and vincristine, in contrast, are obtained from a different genus, the Madagascar periwinkle *Catharanthus roseus* (L.) G. Don (formerly *Vinca rosea*), and not from *V. minor* [3].

In addition, *Vinca* plants contain flavonoids, tannins, phenolic compounds, organic acids and vitamin C, and they are used in traditional medicine as antihypertensive, sedative and circulation-improving remedies. They also protect soil against erosion, grow well in shade and are used in the greening and landscaping of urban environments [4].

Vegetative propagation by stem cuttings is widely used for *Vinca* species, because propagation by seed is reported to give low germination. However, rooting of cuttings is often slow. It depends on the physiological condition of the cuttings, on temperature, humidity and light intensity, and on the supply of auxins, and commercial rooting stimulators are therefore widely applied to accelerate rhizogenesis (the formation of adventitious roots) [5] [6].

The aim of this study was to compare the effects of three commercial stimulators (Gumi-Mix, Kornevin and Rootex Gold) with a distilled-water control on the rooting of *V. major* and *V. minor* cuttings in the Samarkand region, using the proportion of rooted cuttings, the number of roots, root length and the timing of root initiation as response variables.

Results for *V. major* and *V. minor* have been published separately by the authors [6]-[8]. The present paper presents the two species together. The mechanisms of action of the stimulators were not investigated.

2. Materials and Methods

2.1. Study Site, Plant Material and Cuttings

The study was conducted in 2024-2025 at the experimental site of the Samarkand Institute of Agri-Innovations and Research, in a temperate climatic zone with hot, dry summers and relatively mild winters (mean annual temperature +14.5˚C; summer maxima of +35˚C - 37˚C).

Two species were studied: *V. major* L. and *V. minor* L. Cuttings were taken in spring, during active vegetative growth, from healthy and uniformly aged mother plants. Each cutting was 15 - 20 cm long and had at least 2 - 3 nodes; the lower leaves were removed and the upper leaves were retained, and the base was cut at

45˚ to improve the uptake of water and stimulator solution. Vegetative propagation followed the method of Mityakov and Shakina.

2.2. Treatments

Three commercial stimulators were tested (Figure 1). According to the product descriptions, Gumi-Mix is a humic preparation containing humic acids, amino acids and microelements (Fe, Zn, Mn, Cu); Rootex Gold contains indole-3-acetic acid (IAA) and naphthylacetic acid (NAA); and Kornevin is based on indole-3-butyric acid (IBA). Control cuttings were soaked in distilled water. The bases of the cuttings were soaked for 3, 6 or 12 h in each solution, giving 4 solutions × 3 soaking durations for each species.



Figure 1. Growth stimulators used in the experiment: Gumi-Mix, Rootex Gold and Kornevin (left to right).

Stimulators are generally considered to act on auxin- and cytokinin-related processes and on cell differentiation in the basal tissues of cuttings [9]. Substrate, temperature, humidity and light also influence rhizogenesis [10].

2.3. Experimental Design and Rooting Conditions

After soaking, the cuttings were planted in pots filled with sand. Fifty cuttings were used for each combination of species, solution and soaking duration (Table 1), *i.e.* 24 groups and 1200 cuttings in total. Temperature was maintained at 22˚C - 25˚C and relative humidity at about 70% - 80%. Cuttings were kept in natural light without direct sunlight, watered once a week and cultivated under uniform agrotechnical conditions. The experiment lasted 60 days. The labelled pots with cuttings are shown in Figure 2 and Figure 3.

2.4. Assessment

Observations were made every 10 days over the 60-day period. The following variables were recorded: the number of rooted cuttings (expressed as a percentage of the 50 cuttings planted in each group, which is the denominator), the average number of roots per cutting, root length (cm) and the day on which roots were first observed.



Figure 2. Pots with *Vinca* L. cuttings treated with stimulator solutions.



Figure 3. General views of pots with *Vinca major* L. cuttings.

2.5. Statistical Analysis

Rooting is reported as the number and percentage of rooted cuttings per group (n = 50), and all percentages were recalculated from the counts. For each species and solution, the counts from the three soaking durations were pooled (150 cuttings) and 95% Wilson confidence intervals were calculated. These intervals treat every cutting as an independent observation and ignore any clustering of cuttings within pots, so they may understate the true uncertainty. No hypothesis tests were performed, because the experimental unit and the replication have not yet been established (Section 2.3); differences between treatments are therefore described as numerical differences. Root number and length are reported as means or ranges without dispersion estimates.

3. Results

3.1. Rooting of Cuttings

Table 1 gives the number of rooted cuttings in each group. Rooting ranged from 80% to 98% in *V. major* and from 80% to 96% in *V. minor*. In *V. major*, Gumi-Mix gave the highest rooting at every soaking duration (3 h: 44/50, 88%; 6 h: 49/50,

98%; 12 h: 48/50, 96%), followed by Kornevin (84%, 94% and 90%), Rootex Gold (82%, 88% and 84%) and the control (80%, 84% and 82%) [6]. In *V. minor*, Kornevin gave the highest rooting at every soaking duration (3 h: 46/50, 92%; 6 h: 48/50, 96%; 12 h: 45/50, 90%), followed by Gumi-Mix (88%, 94% and 86%); Rootex Gold (82%, 84% and 80%) did not exceed the control (84%, 88% and 80%) [7]. In both species and for all four solutions, 6 h gave the highest rooting.

Table 1. Number and percentage of rooted *Vinca major* and *Vinca minor* cuttings (n = 50 cuttings per group) after soaking for 3, 6 or 12 h. Percentages were recalculated from the counts.

Treatment	Soaking (h)	*Vinca major*		*Vinca minor*	
		Rooted (n)	%	Rooted (n)	%
Control	3	40	80	42	84
	6	42	84	44	88
	12	41	82	40	80
Kornevin	3	42	84	46	92
	6	47	94	48	96
	12	45	90	45	90
Gumi-Mix	3	44	88	44	88
	6	49	98	47	94
	12	48	96	43	86
Rootex Gold	3	41	82	41	82
	6	44	88	42	84
	12	42	84	40	80

Pooled over the three soaking durations (Table 2), rooting in *V. major* was 94.0% with Gumi-Mix, 89.3% with Kornevin, 84.7% with Rootex Gold and 82.0% in the control. The confidence interval for Gumi-Mix (89.0% - 96.8%) did not overlap that of the control (75.1% - 87.3%). In *V. minor*, the pooled values were 92.7% for Kornevin, 89.3% for Gumi-Mix, 84.0% for the control and 82.0% for Rootex Gold, and the intervals for Kornevin and Gumi-Mix overlapped broadly.

Table 2. Pooled rooting (3, 6 and 12 h combined; 150 cuttings per species and solution) with 95% Wilson confidence intervals.

Treatment	*Vinca major*		*Vinca minor*	
	Rooted/150	% (95% CI)	Rooted/150	% (95% CI)
Control	123	82.0 (75.1 - 87.3)	126	84.0 (77.3 - 89.0)
Kornevin	134	89.3 (83.4 - 93.3)	139	92.7 (87.3 - 95.9)
Gumi-Mix	141	94.0 (89.0 - 96.8)	134	89.3 (83.4 - 93.3)
Rootex Gold	127	84.7 (78.0 - 89.6)	123	82.0 (75.1 - 87.3)

Confidence intervals treat each cutting as independent and are descriptive only (Section 2.5).

3.2. Root Traits of Vinca Major

In *V. major*, roots first appeared on day 7 with Gumi-Mix, on day 8 with Kornevin and Rootex Gold, and on day 9 in the control (Table 3). The mean number of roots per cutting was 7 with Gumi-Mix at 6 h and 6 at 12 h, 3 - 5 with Kornevin (6 h) and Rootex Gold, and 2 in the control. Root length was 4.9 cm (Gumi-Mix, 6 h), 4.5 cm (Gumi-Mix, 12 h), 3.8 cm (Kornevin, 6 h), 3.5 cm (Rootex Gold) and about 1.5 cm in the control [6]. Gumi-Mix at 6 h thus had 3.5 times as many roots (7 vs 2) and 3.3 times the root length (4.9 vs 1.5 cm) of the control, and roots appeared 2 days earlier (day 7 vs day 9).

Table 3. Rooting traits of *Vinca major* cuttings.

Treatment	Roots per cutting	Root length (cm)	First roots (day)[a]
Control	2	1.5	9
Kornevin (6 h)	3 - 5	3.8	8
Gumi-Mix (6 h)	7	4.9	7
Gumi-Mix (12 h)	6	4.5	-
Rootex Gold	3 - 5	3.5	8

[a]Values read from the original bar chart; the soaking duration was not stated.

3.3. Root Traits of Vinca Minor

In *V. minor*, roots first appeared on days 7 - 9 with Gumi-Mix, days 8 - 10 with Kornevin, days 9 - 11 with Rootex Gold and days 9 - 12 in the control (Table 4). The number of roots per cutting was 6 - 8 with Gumi-Mix, 5 - 7 with Kornevin, 4 - 6 with Rootex Gold and 3 - 5 in the control, and root length was 5.2 - 6.3, 4.5 - 5.5, 3.8 - 4.6 and 3.0 - 4.3 cm, respectively [7]. Comparing range midpoints, Gumi-Mix cuttings had about 1.8 times as many roots (7 vs 4) and 1.6 times the root length (5.75 vs 3.65 cm) of control cuttings, and roots appeared 2 - 3 days earlier (range limits of 7 and 9 days vs 9 and 12 days). Because these values are ranges without sample sizes or dispersion estimates, the comparison is descriptive.

Table 4. Rooting traits of *Vinca minor* cuttings (ranges as reported).

Treatment	First roots (day)	Roots per cutting	Root length (cm)
Control	9 - 12	3 - 5	3.0 - 4.3
Kornevin	8 - 10	5 - 7	4.5 - 5.5
Gumi-Mix	7 - 9	6 - 8	5.2 - 6.3
Rootex Gold	9 - 11	4 - 6	3.8 - 4.6

3.4. Comparison of Species

Differences between the two species were small and inconsistent. Pooled rooting was higher in *V. major* with Gumi-Mix (94.0% vs 89.3%) and Rootex Gold (84.7% vs 82.0%) but higher in *V. minor* with Kornevin (92.7% vs 89.3%) and in the con-

trol (84.0% vs 82.0%), and all of these differences were small compared with the confidence intervals in Table 2. The data therefore do not show that either species roots better overall.

4. Discussion

Among the products tested, Gumi-Mix gave the highest rooting in *V. major* at every soaking duration, and in *V. minor* it was associated with the earliest root initiation, the most roots and the longest roots, although its rooting percentage was not higher than that of Kornevin (Tables 1-4). Rootex Gold produced a small increase in rooting in *V. major* but no increase in rooting percentage in *V. minor* relative to the control, so a rooting benefit of all stimulators over the control is not supported for every species and product.

A soaking duration of 6 h gave the highest rooting for every solution in both species. However, the control cuttings themselves varied by up to 8 percentage points between soaking durations (*V. minor*: 88% at 6 h vs 80% at 12 h), which indicates the level of variation that cannot be attributed to the treatments; the effect of duration should therefore be interpreted cautiously.

Kornevin (IBA) and Rootex Gold (IAA and NAA) are auxin-based products, whereas Gumi-Mix is a humic preparation. Effects of such products on rooting have been attributed to auxins, humates and microelements that promote cell division and the differentiation of root primordia in the tissues of cuttings [11]. This study did not measure hormone levels, callus formation or tissue anatomy, so the reasons for the differences between the products remain untested.

Root thickness, physiological state and endogenous hormones were not measured, and temperature and humidity were kept within 22˚C - 25˚C and 70% - 80%, so their effects could not be evaluated. Leaf growth, resistance to stress, survival after transplanting and the costs of the treatments were also not measured; this study therefore provides no evidence on these points.

The main limitations are that the experiment was conducted at a single site over one period, that the experimental unit and the replication are not yet defined (Section 2.3), that no inferential analysis was applied, and that root number and length are available only as means or ranges. The results and the recommendation below apply to the conditions tested: spring cuttings, a sand substrate, 22˚C - 25˚C, 70% - 80% relative humidity, the solutions described in Section 2.2 and soaking for 3 - 12 h.

5. Conclusions

1) In *V. major*, soaking cuttings for 6 h in Gumi-Mix gave the highest rooting (49 of 50 cuttings, 98%) compared with 42 of 50 (84%) in the best control group, with 7 vs 2 roots per cutting (3.5-fold), root length of 4.9 vs 1.5 cm (3.3-fold) and roots appearing 2 days earlier (day 7 vs day 9).

2) In *V. minor*, rooting percentages were similar for Kornevin (pooled 92.7%) and Gumi-Mix (89.3%), and both exceeded the control (84.0%). Gumi-Mix was

associated with earlier root initiation (days 7 - 9 vs 9 - 12; 2 - 3 days), about 1.8 times as many roots and 1.6 times the root length of the control (range midpoints).

3) Rootex Gold gave a small increase in rooting in *V. major* (84.7% vs 82.0% in the control) and none in *V. minor* (82.0% vs 84.0%).

4) A soaking duration of 6 h gave the highest rooting for every solution in both species; differences between the species were small and inconsistent, and no mechanism was tested.

Gumi-Mix is a promising stimulator for the propagation of *Vinca* by cuttings under the conditions tested here. Confirmation requires replicated trials with a defined experimental unit, stated concentrations and statistical analysis.

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Author Contributions

Shahnoza T. Pardayeva, Mavluda M. Amanova Conceptualization, methodology, writing—original draft preparation. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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