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# BIOLOGICAL CHARACTERISTICS OF THE SPECIES *HEDERA HELIX* L. AND ITS USE IN CONTROLLING EROSION IN SHADY PLACES

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*Abstract* – Controlling erosion in shady places is among the most serious problems of environment protection, one that requires persistent and strenuous efforts. Ivy (*Hedera helix* L.) is exceptionally shade-tolerant, covers the ground surface nicely, and is easy to cultivate. For these reasons, it can be used more successfully than any other ground cover to control erosion in shady places. Hardening of ivy cuttings is accomplished with semi-lignified and lignified cuttings. In hardening of cuttings in plastic containers, a substrate composed of garden soil and peat proved to be the most effective. Even when the percentage of ivy cuttings that take is low in shady places subject to erosion, the significance of their presence is great in subsequent years, when the ivy spreads over the ground, covering it and retarding erosion of the soil.

*Key words*: *Hedera helix*, erosion control, ground cover

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## INTRODUCTION

Processes of soil erosion represent a great ecological problem in all of the world's countries, our own included. Stabilization of soil is very successfully achieved by sowing seeds and planting seedlings (T u e l l e r, 1997). Slopes are locations where seedlings take root less successfully, and shady places are an even less favorable environment for seedlings and their establishment in the substrate.

In addition to grasses (Poaceae), ground covers can also be used to control erosion on slopes. Plant species that grow rapidly, reproduce readily, and cover large areas are used as ground covers (B i l l e t, 2000). Ground covers can be divided into ones that are used in sunny places (*Arabis albida*, *Aubretia deltoidea*, *Alyssum maritimum*, *Centaurea montana*, *Cerastium tomentosum*, *Dianthus hybridum*, *Erica carnea*, *Helianthemum hybridum*, *Iberis sempervirens*, *Polygonum zonale*, *Sedum acre*, and *Thymus serpillum*) and ones that are used in shady places (*Ajuga reptans*, *Asarum europaeum*, *Asperula odorata*, *Bergenia cordifolia*, *Clematis orientalis*, *Cotoneaster dammeri*, *C. microphyllus*, *Dicentra formosa*, *Euonimus fortunei*, *Geranium sanguineum*, *Hedera helix*, *Hosta japonica*, *Juniperus chinensis*, *Mahonia aquifolium*, *Prunus laurocerasus*, and *Vinca major*) (B u c z a c k i and H a r r i s, 2000).

The problem of protecting inclined shady terrains from erosion can be most simply resolved by planting seedlings of ivy (*Hedera helix* L.). This species is exceptionally shade-tolerant, covers the ground surface nicely, and is easy and inexpensive to cultivate. For these reasons, it can be used more successfully than any other ground cover to control erosion in shady places.

## METHOD

Morpho-anatomical characteristics of ivy were analyzed. Year-old cuttings of ivy from tree trunks and cuttings of the given plant creeping on the ground were taken for purposes of experimentation. The cuttings were hardened in a set of hard plastic containers. Four different substrates were used to determine the suitability of substrates for hardening: 1) "Galicina" peat; 2) garden soil; 3) 50% "Galicina" peat + 50% garden soil; and 4) 30% "Galicina" peat + 40% garden soil + 30% sand.

Hardened cuttings were planted in a place selected in the schoolyard of the Strahinja Banović Elementary School on the Banovo Brdo hill in Belgrade. The place where they were planted was in the shade of several large trunks of Austrian pine (*Pinus nigra*) on a very steep incline of 60°. The cuttings were set out in planting holes dug without preliminary basic processing of the ground surface as a whole, which was impossible due to the highly branching surface root system of the pine trees and the exceptionally steep incline of the ground.

Constant monitoring was carried out over the entire course of the experiment, which lasted two years (2005-2006). The state of hardening and successful rooting of plants were observed at the permanent sites every month during the first year. Observations were made from time to time during the next year.

### *Objectives*

The main objectives of this investigation were to select a plant species, evaluate the possibility of its cultivation in containers, and analyze its usefulness in controlling processes of erosion on shady inclined ground in populated areas. Other aims of the study were to establish the kind of ivy cuttings most suitable for hardening during the spring and analyze the best type of substrate for this method of producing hardened cuttings. In order to satisfy the market demand for inexpensive hardened cuttings, we omitted feeding of cuttings, treatment with phytohormones for hardening, and use of plastic tenting.

### *Morphological Characteristics*

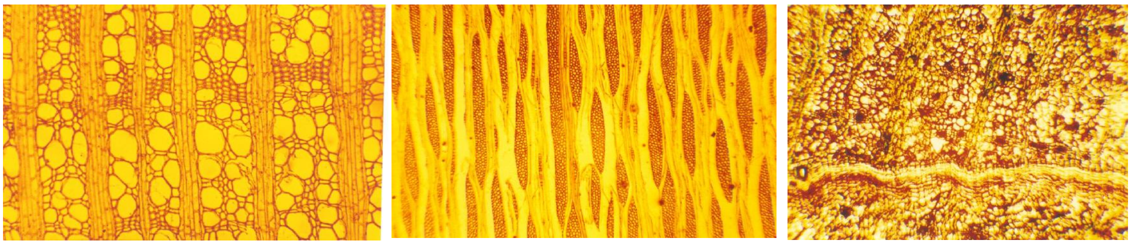
Ivy (*Hedera helix* L.) is a woody vine that climbs on a vertical support or creeps on the ground. It can attain a height of up to 30 m and stem diameter of up to 20 cm. It climbs with the aid of aerial adventitious roots. Young shoots are stellately hairy initially, but naked later on. The leaves are spirally arranged, leathery, dark-green on the upper side, shiny, naked, lighter- or yellowish-green on the under side, and with gray stellate hairs when young; on sterile shoots, they are roundly ovoid or drawn-out in width, and three- to five-lobed; on fertile shoots, they are broadly or rhombically ovoid, rarely with a single lobe, and sometimes asymmetrical. The shield-shaped racemes are 20-35 (40 mm) in diameter on stalks 1.7-3.5 cm long; all parts of the flower are stellately hairy. The flowers are usually dioecious; teeth of the calyx are poorly developed; petals of the corolla are greenish. The fruits are round, mature fruits being bluish-black berries measuring 8-10 mm in diameter and having two or three (five) seeds. Flowering occurs from September to October, and fruits ripen from March to April (June). The plant grows slowly and is long-lived (Vukičević, 1996).

*Hedera helix* is a species with a fairly large number of varieties and forms, which are grown both in gardens and as pot cultures. According to Vukičević (1996), the most widespread varieties and forms are "Arborescence" (*H. arborea* hort.), "Argenteo-variegata," "Conglomerata," "Glumii," "Erecta," and "Aureo-variegata."

### *Anatomical Characteristics*

Analysis of anatomical cross-sections indicates that ivy has the typical structure of leafy species. Conducting elements consist of tracheae lacking spiral thickenings and having a simple perforation. They are evenly arranged in groups and differ little among themselves in width, which puts ivy in the group of diffusely porous species. Mechanical elements established in ivy consist of woody fibers of the thickened cell walls in the late zone of wood. Radial parenchyma is represented by wide homocellular bands of lignum (Stavretović et al., 2005).

Specific aspects of anatomical structure of the analyzed cross sections include the greater representation of conducting elements in relation to mechanical ones. Tracheae with especially wide lumina have been established in the species *Tecoma radicans* (Stavretović et al.,



a b c

Fig. 1. a) Cross section of ivy; b) tangential section of ivy; c) anatomical cross section of ivy cortex (photograph: G. Radošević).

Table 1. Calendar of experiment.

| 2005/06 | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taking of cuttings | | | | 03 | | | | | | | | |
| Hardening of cuttings | | | | 03 - | | | 16 - | | | | | |
| Planting of cuttings | | | | | | | 16 | | | | | |
| Monitoring, 2005 | | | | | | | 16 and 29 | 29 | 27 | 24 | 28 | 20 |
| Monitoring, 2006 | 29 | | | 12 | 18 | | | | | | | |

2001), making a faster flow of water possible. A similar high percentage of tracheae with wide lumina in ivy contributes to good circulation of water with dissolved mineral substances.

Bands of lignum in ivy are numerous and conspicuous for their height and width. Their role is to ensure exchange of substances in the radial direction, accumulation of nutrients, and aeration of the stems. The abundance and size of these elements of anatomical structure in ivy indicate that it is a specific plant form, e.g., a woody vine (S t a v r e t o v i ć et al., 2005).

*Production of Cuttings*

Production of ivy cuttings was initiated on the 3rd of April in 2005, and hardened cuttings were transplanted at the permanent sites on the 16th of July. Monitoring was carried out on a monthly basis, except in February and March of 2006 (Table 1).

Out of a total of 344 cuttings set out to harden, it was established in monitoring conducted after a period of four months that 70% hardened successfully. The highest percentage of unhardened cuttings was recorded in green cuttings that underwent hardening in large containers. In this case, 88 out of a total of 160 cuttings or only 55% were hardened. On the other hand, when semi-mature cuttings were set out to harden, 140 out of 184 cuttings or 76% developed into hardened plants (Table 2).

*Planting of Cuttings at Permanent Sites*

All eight groups of seedlings were planted on an area of about 50 m$^2$, the area for individual groups depending on the number of seedlings in the group. The groups contained the following numbers of seedlings:

Group I - garden soil; small container 38 seedlings;

Group II - garden soil; large container 24 seedlings;

Table 2. Hardening of cuttings in containers with different substrates at different times of monitoring (*Containers with 53 planted cuttings; **Containers with 33 planted cuttings).

| **Failed cuttings** | **Garden soil*** | **Garden soil**** | **Garden soil + peat*** | **Garden soil + peat**** | **Garden soil + peat + sand*** | **Garden soil + peat + sand**** | **Peat*** | **Peat**** |
|---|---|---|---|---|---|---|---|---|
| 19.04.2005 | 3 | / | 2 | 3 | 1 | / | 3 | 1 |
| 29.04.2005 | 1 | 1 | 5 | 1 | 5 | 2 | 4 | 5 |
| 13.05.2005 | 6 | 7 | 5 | 2 | 6 | 5 | 13 | 7 |
| 30.05.2005 | 2 | / | 1 | 3 | 3 | 1 | 3 | 3 |
| 29.06.2005 | 3 | 1 | / | / | 4 | 1 | 2 | 1 |
| 16.07.2005 | Σ=15 | Σ=9 | Σ=13 | Σ=9 | Σ=19 | Σ=9 | Σ=25 | Σ=17 |
| Total successful cuttings | **Σ=38** | **Σ=24** | **Σ=40** | **Σ=24** | **Σ=34** | **Σ=24** | **Σ=28** | **Σ=16** |

Group III - garden soil + peat + sand; small container 34 seedlings;

Group IV – peat; small container 28 seedlings;

Group V - garden soil + peat; large container 24 seedlings;

Group VI - garden soil + peat; small container 40 seedlings;

Group VII - peat - large container 16 seedlings;

Group VIII - garden soil + peat + sand; large container 24 seedlings.

Seedlings were monitored 11 times over the next 11 months. Table 3 presents data on the number of failed and succussful cuttings.

lower percentage of successful hardening of cuttings (Table 2).

The highest percentage of seedlings taking root at the permanent sites was obtained from cuttings hardened in a substrate of garden soil. This fact can be attributed to good adaptability of the species to environmental conditions where quality of the substrate for hardening of cuttings differed little from that of the substrate at the permament sites. The percentage of ivy seedlings taking root at the permanent sites can be increased by conducting better preparation of the planting substrate and by nurturing the planted seedlings, primarily through feeding and protection from harm caused by humans (damage resulting from trampling, winter sledding, etc.).

Table 3. Number of successful and failed seedlings from the above-mentioned groups at different times of monitoring of the permanent sites. a) Successful seedlings; b) failed seedlings.

| **Date** | **29.07.05** | | **29.08.05** | | **27.09.05** | | **24.10.05.** | | **28.11.05** | | **20.12.05** | | **29.01.06** | | **Feb.** | | **March** | | **12.04.06** | | **18.05.06** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** | **a** | **b** |
| I | 38 | | 38 | | 38 | | 36 | 2 | 33 | 3 | 32 | 1 | 25 | 7 | | | | | 22 | 3 | 22 | |
| II | 23 | 1 | 22 | 1 | 22 | | 20 | 2 | 18 | 2 | 18 | | 14 | 4 | | | | | 1 | 13 | 8 | |
| III | 34 | | 34 | | 34 | | 34 | | 34 | | 31 | 3 | 25 | 6 | | | | | | 25 | 3 | |
| IV | 25 | 3 | 24 | 1 | 23 | 3 | 20 | 3 | 16 | 4 | 16 | | 13 | 3 | | | | | | 13 | | |
| V | 24 | | 23 | 1 | 23 | | 23 | | 23 | | 20 | 3 | 15 | 5 | | | | | 9 | 6 | 9 | |
| VI | 37 | 3 | 32 | 5 | 30 | 2 | 28 | 2 | 25 | 3 | 22 | 3 | 22 | | | | | | 4 | 18 | 4 | |
| VII | 15 | 1 | 15 | | 15 | | 15 | | 14 | 1 | 14 | | 12 | 2 | | | | | 1 | 13 | 3 | |
| VIII | 21 | 3 | 21 | | 18 | 3 | 17 | 1 | 17 | | 15 | 2 | 13 | 2 | | | | | | 13 | | |

## CONCLUSION

Owing to all of the shortcomings of the experiment in combination with unfavorable climatic conditions, 228 seedlings from a total of 344 cuttings set out in a substrate for hardening (70%) were planted at the permanent sites. After a whole year of monitoring the gradual failure of plants, it was concluded that the experiment was only partially successful, since only 49 seedlings (14%) took root at the permanent sites. Nevertheless, the experiment described and analyzed herein gives results that are significant for further work with and use of ivy to control processes of erosion in shady places.

For hardening of ivy cuttings, it is necessary to use semi-lignified and lignified cuttings. The number of hardened cuttings can be increased in this way. The use of phytohormones is also recommendable. The best substrate for hardening of cuttings in plastic containers turned out to be one composed of garden soil and peat. The next best substrate was garden soil alone, followed by garden soil + peat + sand. Other substrates yielded a

Despite the relatively small number of ivy seedlings successfully taking root in the substrate, the significance of this experiment is not negligible in view of the expansion of ivy-covered terrain during the third and fourth years after planting. Control of erosion in shady places is a serious problem in practice. This study presents a way of resolving the given problem and suggests basic directions for further investigation, which is unquestionably needed.

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## БИОЛОШКЕ КАРАКТЕРИСТИКЕ ВРСТЕ *HEDERA HELIX* L. И ЊЕНА УПОТРЕБА ПРИ КОНТРОЛИ ЕРОЗИЈЕ НА СЕНОВИТИМ МЕСТИМА

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Контрола ерозије на засенченим местма сврстава се међу најозбиљније проблеме заштите природе. Бршљан (*Hedera helix* L.) је нарочито толерантан на засенчења, покрива широке површине и лак је за култивисање. Из тих разлога може се користити са већим успехом од било ког другог земљишног "прекривача" у смислу ерозије сеновитих места. Очвршћавање резница бршљана је вршено са семи-лигнификованим и лигнификованим резницама. При очвршћавању резница у пластичним контејнерима, најефективнијим се показао супстрат састављен од баштенског земљишта и блата. Чак и код резница које испрва нису разрастале одмах након сађења, наредних година дошло је до значајног ширења бршљанове покривке на сеновитим местима.