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THE INFLUENCE OF EXPOSURE ON THE ACCLIMATIZATION AND FOLIAR RESPONSE OF *FATSIA JAPONICA* 'Spider's Web' DURING OUTDOOR WINTERING

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ABSTRACT

Plants cultivated indoors are generally maintained under relatively stable temperature, humidity, and light conditions, which may differ considerably from those encountered in outdoor environments. Their transfer to outdoor conditions during winter may represent a significant challenge, particularly when plants are exposed to low temperatures, frost, and fluctuations in weather conditions. Such environmental changes may affect leaf appearance and condition, as well as the plants' ability to withstand outdoor winter conditions. The present study investigates the acclimatization of Fatsia japonica 'Spider's Web' specimens under winter conditions in Bucharest, Romania. The experiment comparatively evaluated specimens maintained under partial shade and those exposed to direct morning sunlight in an east-facing position. Observations were conducted throughout the wintering period, with particular emphasis on the foliar response of the plants under the two exposure conditions. The aim of the study was to evaluate the overwintering response of Fatsia japonica 'Spider's Web' under outdoor winter conditions in Bucharest, with particular emphasis on survival, vegetative characteristics, foliar damage and subsequent recovery and reproductive development under contrasting exposure conditions.

INTRODUCTION

Fatsia japonica (Thunb.) Decne. & Planch. belongs to the family Araliaceae and is commonly known as the paperplant, Japanese aralia, or "false castor oil plant". The genus *Fatsia* was established by botanists Joseph Decaisne and Jules Émile Planchon in 1854, when *Fatsia japonica* was formally described. The generic name *Fatsia* is generally considered to derive from an adaptation of the Japanese name "Fatsi" associated with the traditional Japanese name *yatsude* (八つ手), referring to the palmately lobed shape of the leaves, which resembles a hand with multiple fingers.

The species is an evergreen shrub or small tree that can reach approximately 5–6 m in height and is native to Japan and Korea (Bailey & Bailey 1976, Krüssmann 1977, Xiang & Lowry 2007, Missouri Botanical Garden 2026). It is widely cultivated for its attractive vegetative characteristics and ornamental flowers. The leaves are palmately lobed, commonly bearing seven to nine deep lobes (NC State University 2026). The inflorescence is a panicle composed of umbels, with the main axis reaching 20–40 cm in length. The peduncles are approximately 10–15 cm

long, while the umbels, measuring 3–4 cm in diameter, bear numerous flowers (Lowry & Frodin 2007).

In addition to its ornamental value, *Fatsia japonica* has attracted attention due to the biological properties of its triterpenoid glycoside-rich extracts. These compounds have been reported to exhibit anti-inflammatory and anti-arthritic effects (Tsiklauri et al. 2019). Antioxidant and neuroprotective effects have also been reported for the species (Liu et al. 2024).

The selected taxon for this study was *Fatsia japonica* 'Spider's Web', a variegated cultivar originating from Japan, particularly from the southern regions of the country. It is a selected and named cultivar that has been attributed in some horticultural sources to Mr. Hirose of Iwakuni. The name 'Spider's Web' refers to the fine white-silver speckles and streaks that extend across the margins and surface of the green, palmately lobed leaves.

The selection of this taxon for the present study was motivated by both its ornamental value and its potential for adaptation to the climatic conditions of temperate regions. Native to East Asia, *Fatsia japonica* is valued for its distinctive morphological characteristics and its ability to grow under low-light conditions, which has contributed to its widespread use as an ornamental plant. Evaluating its performance under the climatic conditions of Romania may contribute to a better understanding of its acclimatization capacity, growth dynamics, and phenological characteristics outside its native range.

MATERIALS AND METHODS

Fatsia japonica 'Spider's Web' belongs to USDA hardiness zones 7–11, which correspond to minimum annual temperatures between –17.7°C and –1.1°C. The taxonomy used is in accordance with the Plants of the World Online (POWO 2026). The experimented specimens were sourced in May 2024 from a nursery specializing in *in vitro* propagation, ensuring genetic uniformity and appropriate phytosanitary status. The plants were established at two locations within the “Dimitrie Brândză” Botanical Garden of the University of Bucharest: the experimental plot, situated in an east-facing area characterized by indirect morning light and moderately favourable microclimatic conditions for plants sensitive to thermal stress, and the Ornamental Sector, in a shaded area characterized by reduced light availability. To assess winter survival under natural outdoor conditions, the plants were maintained outdoors throughout the winter period and were not transferred to protected environments. As a form of passive protection against low temperatures, a 20–25 cm layer of dry leaves was applied around the base of the plants. This measure was intended to create a favourable microclimate at soil level and to reduce the amplitude of nocturnal temperature fluctuations. Average winter air temperatures in Bucharest were monitored and are presented in Table 1 to provide the climatic context necessary for interpreting survival, phenological patterns, and morphological damage at the end of the cold season.

Table 1.

Average Monthly Temperatures – Bucharest

Average Temperature	**Dec. 2024**	**Jan. 2025**	**Feb. 2025**	**Dec. 2025**	**Jan. 2026**	**Feb. 2026**
	4°C	4,3°C	-0,6°C	3,3°C	-0,5°C	1,5°C

RESULTS AND DISSCUTIONS

All plants survived the winter period without any visible damage, as shown in Table 2.

Table 2

Winter Survival Rate of *Fatsia japonica* 'Spider's Web'

Taxon exposure	Survival Rate
Full-shade exposure	100 %
East-facing exposure	100 %

During the winter period, the lowest recorded temperatures at the Bucharest-Băneasa meteorological station were −8.9 °C in December 2025, recorded on 26 December, −14.8 °C in January 2026, recorded on 13 January, and −14.2 °C in February 2026, recorded on 3 February. Thus, the lowest temperature recorded during the study period was −14.8 °C, in January 2026.

As shown in Table 3, the lowest temperature was recorded in January, according to data provided by the Romanian National Meteorological Administration (ANM).

Table 3

Minimum temperatures recorded at the Bucharest-Băneasa meteorological station during the winter period of 2025–2026

Month lowest temperature	Date	Meteorological station
December 2025	- 8.9° C - 26 December	Bucharest-Băneasa
January 2026	**- 14.8° C - 13 January**	Bucharest-Băneasa
February 2026	- 14.2° C - 3 February	Bucharest-Băneasa

The plants of *Fatsia japonica* 'Spider's Web' monitored under outdoor conditions throughout the wintering period exhibited differential responses depending on the exposure conditions. The two specimens were maintained under contrasting light conditions: one was placed in an east-facing position, characterized by direct exposure to solar radiation during the first part of the day, while the other was maintained under shade conditions.

Figure 1 presents *Fatsia japonica* 'Spider's Web' maintained under shade conditions, while Figure 2 presents the same taxon maintained under east-facing exposure.

The assessment of the biometric characteristics of *Fatsia* plants (table 4) maintained under two distinct light exposure conditions revealed differences in plant height, leaf size, and leaf number per plant. Plants grown under east-facing exposure reached a mean height of 50 cm, compared with 45 cm for those maintained under shade conditions. Consequently, plants exposed to eastern light conditions exhibited an approximately 11.1% greater mean height than plants grown under shade. This difference may indicate enhanced vegetative growth under conditions of increased light availability, suggesting that the higher light intensity associated with east-facing exposure may have promoted plant growth and development.



Figure 1. *Fatsia japonica* 'Spider's Web' under shade exposure



Figure 2. *Fatsia japonica* 'Spider's Web' under east-facing exposure

Table 4

Biometric characteristics of *Fatsia* plants under different light exposure conditions

Feature	Shade Exposure	Eastern Exposure	Difference
Plant height (cm)	45	**50**	+11.1 %
Leaf diameter (cm)	**15.8**	14.0	−11.4 %
Number of leaves per plant	17.5	**23.5**	+34.3 %

Regarding the leaf size, plants maintained under shade conditions exhibited a mean leaf diameter of 15.8 cm, whereas plants under east-facing exposure recorded a mean value of 14.0 cm. Consequently, the leaves of plants grown under shade conditions had an approximately 11.4 % greater mean diameter than those of plants exposed to sunlight during the first part of the day. The larger leaf size observed under shaded conditions may represent a morphological response to reduced light availability, involving an increase in the leaf area available for radiation capture. Under conditions of higher light intensity, the development of relatively smaller leaves may constitute an adaptive characteristic associated with exposure to a higher light regime.

A more pronounced difference was observed in terms of the number of leaves per plant. Plants maintained under east-facing exposure exhibited an average of 23.5 leaves per plant, compared with 17.5 leaves per plant under shade conditions, representing an approximately 34.3 % higher value. This result indicates a more pronounced development of the foliage under east-facing exposure, despite the smaller individual leaf diameter. Therefore, the response of the plants to light conditions was manifested not only through changes in individual leaf size but also through changes in leaf number.

Taken together, the recorded values suggest the presence of distinct morphological strategies in response to different light conditions. Under shade conditions, plants exhibited larger individual leaves but a lower number of leaves per plant, whereas east-facing exposure was associated with slightly taller plants and a greater number of leaves, but with a smaller individual leaf size. This type of response may reflect an adjustment of foliage architecture to the prevailing light regime.

It is important to note that, in the absence of statistical analysis and a sufficient number of replicates, the observed differences do not allow for the conclusion that exposure had a statistically significant effect on the traits examined. Furthermore, in the case of plants maintained outdoors, light exposure is accompanied by concurrent variations in temperature, humidity, and water loss through evapotranspiration. Therefore, the results should be interpreted as highlighting morphological differences associated with the two growing conditions, without attributing these differences exclusively to the light factor.

The specimen maintained under east-facing exposure survived the overwintering period and exhibited symptoms of leaf necrosis at the beginning of the growing season. Foliar damage was observed concurrently with the resumption of vegetative activity, as shown in Figure 3; however, despite the deterioration of part of the foliage, the plant retained its reproductive capacity, as evidenced by the occurrence of flowering. This observation indicates that the foliar damage sustained during the overwintering period did not evidently compromise the plant's ability to resume growth and initiate the flowering process.



Figure 3. Necrotic leaves on *Fatsia japonica* 'Spider's Web'

The occurrence of foliar necrosis was observed in specimens maintained under eastern exposure, whereas no visible necrotic symptoms were observed in specimens maintained under full-shade conditions. This difference may indicate a possible association between exposure conditions and the manifestation of post-overwintering foliar stress.

The development of necrosis under eastern exposure may be associated with the combined effects of abiotic factors characteristic of the overwintering and early spring periods. Low temperatures during winter can cause physiological and structural changes in the leaves of *Fatsia japonica*, potentially reducing their capacity to withstand subsequent environmental stress (Wang et al. 2016). Following the

overwintering period, the leaves were exposed to periods of direct solar radiation, and the abrupt changes in light and temperature conditions may have contributed to the development or intensification of foliar lesions.

The symptoms may instead reflect the interaction between low temperatures during winter, tissue dehydration, and subsequent exposure to direct solar radiation.

In contrast, as shown in Figure 4, specimens maintained under shade conditions were not directly exposed to solar radiation, and the absence of visible necrotic symptoms under these conditions may indicate a potential role of the light regime in the manifestation of post-overwintering stress. Nevertheless, differences between the two cultivation conditions cannot be attributed exclusively to light intensity, as cultivation position may simultaneously influence several microclimatic parameters, including temperature, thermal amplitude, substrate water loss, and exposure to air currents. Therefore, the observed results should be interpreted as an association between exposure conditions and the occurrence of foliar necrosis, rather than as evidence of a direct causal relationship with solar radiation.



Figure 4. *Fatsia japonica* 'Spider's Web' under shade conditions

A noteworthy finding was the resumption of reproductive activity in the specimen maintained under eastern exposure, providing evidence of its physiological recovery following the overwintering period. The first flower buds were observed in Figure 5, indicating the resumption of developmental activity. Two weeks later, continued development of the flower buds was observed (Figure 6), followed by flower opening after a further two weeks (Figure 7). This sequence of developmental stages indicates that, despite the occurrence of foliar necrosis following overwintering, the specimen retained sufficient physiological capacity to resume growth and progress through the reproductive stages.

These observations suggest that tolerance to overwintering conditions should not be assessed solely based on foliar damage. The plant's ability to recover physiologically and progress through subsequent developmental stages, including flower bud formation and anthesis, should also be considered when evaluating its response to unfavourable environmental conditions.



Fig. 5. Initial formation of flower buds following the overwintering period (3.11.2025)



Fig. 6. Development of flower buds two weeks after their initial formation (17.11.2025)



Fig. 7. Flower opening four weeks after initial formation of flower buds (30.11.2025)

CONCLUSIONS

Based on the observations conducted, it can be concluded that the specimens of *Fatsia japonica* demonstrated a capacity for recovery following the overwintering period, even under conditions in which symptoms of foliar damage were present. The occurrence of necrosis in specimens maintained under eastern exposure, together with the absence of visible symptoms in specimens maintained under shade conditions, suggests a possible influence of exposure conditions on the manifestation of post-overwintering stress.

The foliar necrosis observed under eastern exposure cannot be attributed exclusively to solar radiation. It is possible that the symptoms resulted from the interaction between low temperatures during winter, tissue dehydration, and subsequent exposure to direct solar radiation, accompanied by rapid changes in temperature and light conditions. In this context, the results highlight the importance of considering interactions among environmental factors rather than the effect of a single abiotic factor in isolation.

A particularly relevant finding was that the occurrence of foliar necrosis did not prevent the resumption of reproductive activity in the specimen maintained under eastern exposure. The formation and subsequent development of flower buds, followed by flower opening, demonstrate that the plant retained sufficient physiological capacity to resume development and progress through the reproductive stages following the overwintering period.

Therefore, the assessment of overwintering tolerance should not be based exclusively on the degree of foliar integrity. The plant's ability to resume growth, form reproductive structures, and continue its development following a period of stress should also be considered as relevant indicators of its recovery capacity.

Overall, the results indicate that Fatsia japonica has a capacity for post-overwintering recovery, although the plant's response may vary depending on the exposure conditions. The observations provide indications of a potential role of the light regime and microclimatic conditions in the manifestation of foliar stress; however, further investigations are required to elucidate the mechanisms involved.

To **further investigate** and expand upon these findings, future research could focus on several directions:

Monitoring leaf temperature – Measuring actual leaf temperature would help distinguish the effects of ambient temperature from those associated with solar radiation.

Measuring radiation intensity – Recording photosynthetically active radiation (PAR) and/or total solar radiation under each experimental condition would provide a more accurate characterization of the light regime.

Monitoring substrate moisture – Since tissue dehydration may contribute to the development of foliar lesions, monitoring water availability in the substrate throughout the overwintering and early spring periods would provide valuable information regarding its potential contribution to foliar stress.

Longer-term monitoring – Monitoring the plants throughout the entire growing season would allow assessment of the extent to which initial foliar necrosis affects vegetative growth, flowering, and subsequent plant development.

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