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INTRODUCTION OF A NEW FRUIT SPECIES TO EUROPE THROUGH DIFFERENT TYPES OF PROPAGATION: ASIMINA TRILOBA (L.) DUNAL

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ABSTRACT

Pawpaw (Asimina triloba L. Dunal), also known as the Northern banana, is a temperate species belonging to the predominantly tropical family Annonaceae. In recent years, pawpaw has emerged as a promising novel fruit crop in Romania, attracting increasing interest due to its adaptability to temperate climates. This study evaluates the response of several Asimina triloba (L.) Dunal genotypes to generative and vegetative propagation methods. Although seed propagation is traditional for pawpaw, grafting remains the most effective technique for multiplying and maintaining superior cultivars for commercial orchards and germplasm conservation. The research comprised two complementary experiments. The first addressed seed propagation over several years, with seeds from distinct genotypes sown under controlled greenhouse conditions each spring. Temperature and relative humidity were optimized to ensure uniform germination and seedling growth. The second experiment focused on vegetative propagation by grafting, assessing graft success, annual growth, and the influence of grafting height on plant vigor. Rootstocks were seedlings or suckers, while scions were grafted by chip or T-budding in April–May.

INTRODUCTION

On the European continent, the species Asimina triloba L. Dunal has been present in Italy since 1801, as shown by the statement on one of the historical plaques found at the Botanical Garden of Padova. Written evidence attests to the existence of the species Asimina triloba L. Dunal in the Botanical Garden of Zurich since the beginning of the 20th century. Specimens of this tree disappeared after World War II (1941), despite repeated germinations with seeds originating from the Botanical Garden of Zurich (Bellini et al., 1992).

In an informative article from 1989, it is mentioned that on the territory of Romania, Asimina triloba L. Dunal plants were first encountered as scattered trees 50-60 years ago in the commune of Pianu de sus (Alba county) (Cepoiu et al., 2004).

The species was introduced to Romania by a family of immigrants from northwestern Transylvania (Pianu de Sus, Alba County), who at the beginning of the 20th century were the first Romanians interested in Asimina triloba L. Dunal plants. In 1926, members of the immigrant family (the Suciu family) returned from Ohio (USA) to Romania with several fruits and seeds of Asimina triloba L. Dunal (Stănică, 2012).

Other specimens of Asimina triloba L. Dunal are currently found in Romania and in other locations such as: in the "Dimitrie Brândză" Botanical Garden of the University of Bucharest, a specimen over 30 years old grows, near the town of Geoagiu (Hunedoara County), in a park in the town of Simeria and for over 20 years in the teaching field of the Department of Fruit Growing at the Faculty of Horticulture of USAMV Bucharest (Cepoiu et al., 2004).

Asimina triloba L. Dunal is a species with huge potential in terms of its adaptability to the pedoclimatic conditions in our country, its resistance to diseases and pests in the conditions in our country that recommend it for organic cultivation, the fruits that look attractive, an unusual taste, meeting aromas of banana, mango, pineapple and vanilla, an important content in carbohydrates and fiber, in vitamins B and C, mineral elements P, Mg, K and essential acids.

Germination is also good if it is sown in pots in autumn and left to winter outside. The emergence takes place in June-July and the seedlings grow in the first year only 5-10 cm. After emergence, the plants grow in the shade, transplanting into larger pots when needed. The growth of the seedlings is slow in the first 2-3 years, and the first fruits can be obtained in the 5-6th year after sowing (Stănică et al., 2002)

Whole sale seedlings like this are meant for wildlife plantings and reforestation, not fruit marketing. Modern orchardists growing other common fruits to go to market would virtually never consider planting an orchard of seedling trees.

Pawpaw seedlings potentially can live much longer than grafted pawpaw trees. When grown in excellent conditions, grafted pawpaws have a productive life of about 15–20 years before they slowly stop producing fruit and go into decline and die. In decent but not optimal conditions, they have about 15 to 20 years of good production before starting to decline. Seedling trees allowed to create suckers and spread can live for decades, possibly a century or more. So, if longevity is a main concern to you, plant high-quality potted seedlings of good genetics, or otherwise integrate them into your orchard operation. It’s probably a good idea to give the seedlings their own row or area, so that they can sucker somewhat, if this is what you’re after. However, most of us will be plenty content with two decades of solid production from a grove, and will have probably planted another fresh new grove within that time frame anyway to replace the first grove that will soon decline. Seedlings grown from excellent genetic backgrounds (parent trees) often produce excellent quality fruit. However, unless utilizing grafted trees, it’s always somewhat of a gamble because some of those will not prove as good as the parents (though likely not awful like many random seedlings are). Remember, if you want premium fruits, plant premium trees. This is the same path most modern farmers take whatever they raise.

There are good reasons for not growing an orchard of seedlings: Seedlings can have any number of different characteristics that may or may not be conducive to your operation.

Seedlings generally take longer to produce fruit than grafted trees. Most seedlings are derived from wild-grown pawpaws or a random assortment of genetics.

Most seedling trees are only available shipped to you bare-root (COTHRON, 2021)

Another very important way of propagating the Asimina triloba L. Dunal species is grafting, the method of grafting under the bark into the grafting head was used. According to the calendar, the grafting is done in the months of May and the beginning of June. The bark should come off easily from the graft port, and the graft should be harvested from the previous winter.

The rootstock is grafted at the grafting height. A longitudinal incision, 3-3.5 cm long, is then made on one of the parts and the bark is gently detached from the wood with the spatula.

The graft is grown in the form of a simple wedge. For this, the graft branch is held in the left hand with the base to the right and the bud towards the grafter. With the knife blade in a vertical position, an oblique section will be made from one side to the other of the grafted branch.

Then twisting the graft branch with the buds up, detach from the 2 sides of the simple feather, two strips of bark, 2-3 mm wide.

The cutting is then shortened to 2-3 buds and inserted under the bark of the rootstock next to the longitudinal section. By pressing lightly, the air between the grafts and the rootstock is eliminated (Stănică et al., 2002)

Pawpaws graft easily and in good conditions will live and produce fruit after about 3 to 5 years in the ground, and continue to produce fruit for about 15 to 20 years before they begin to decline in production, leaf size, and canopy cover and subsequently die off. 1 Seedlings live indefinitely if allowed to sucker and spread. However, 20 years is a relatively long time and gives an orchard a decent lifespan. Fresh grafted specimens can be planted elsewhere within that time frame to allow for the perpetuation of the operation if desired.

When planting grafted trees, you know what you're going to get. When you plant a 'KSU Atwood' pawpaw tree, you know that in good conditions it will produce copious amounts of medium-sized, sweet tasty fruit with low seed weight and good Phyllosticta resistance. However, when planting seedling trees, you don't know exactly what characteristics they will display. If you plant seedlings from parents of excellent genetics, then many of them will most likely be very high-quality fruit producers. Yet for the commercial grower, it just makes sense to mostly plant grafted trees, especially if the goal is to sell premium-quality fruits destined to markets or stores. If you were to plant an entire orchard of seedlings, only to find 4 or 5 years later that they produce small inferior fruits, then that could prove to be very problematic, and not easily solved. The best thing to do in that case would be to top-work (graft) most of the inferior trees over to named cultivars as soon as possible. Top-working pawpaw trees have been shown to be effective for that purpose, but will take a few years to regrow large enough to start producing fruit again (COTHRON, 2021)

A study "Comparison of Grafting and Budding Propagation Techniques for Cultivars of the North American Pawpaw"compared several methods: whip-and-tongue grafting, cleft grafting, chip budding, T-budding, green bud grafting. Whip-and-tongue had the best survival rates (around 95.8 %), followed by cleft grafting (~66.7 %), chip budding (~50 %), T-bud (~25 %), green bud (~0 %) under their experimental conditions. This suggests that for high graft success, choosing the appropriate technique (and good quality scion wood) is critical. The method also interacts with cultivar/genotype somewhat, but the method seems to have a bigger influence (Layne et al., 2019).

A paper "Cytokinin habituation for autonomous shoot initiation in pawpaw" (Geneve, Kester, Pomper) reports on micropropagation: shoot-bud cultures maintained on media containing BA (6-benzylaminopurine) and NAA (naphthalene acetic acid) over 5 years show habituation to cytokinin. Single shoot buds moved to media without plant growth regulators still initiated multiple shoot-buds (5-8 per culture). However, elongation of shoots was limited when PGRs were present. The evidence indicates that tissue culture is feasible, but there are challenges, especially shoot elongation, rooting, and perhaps cost/complexity. Useful for clonal propagation and germplasm preservation (Geneve et al., 2007).

Plants use light in the photosynthetically active radiation spectrum, which includes wavelengths ranging from 400 (violet) to 700 (red) nanometers. Typically, plants use more blue and blue-green light when they are seedlings, and more red light later on in their life cycles when they begin to flower and produce seeds (https://extension.umn.edu/)

The light signaling pathway plays a crucial role in plant growth, development, and adaptation to their environment. Specialized photoreceptor molecules allow them to perceive light, the transformation of light signals into biochemical changes, and subsequent regulation of various physiological and developmental responses. These photoreceptors can be categorized into five classes based on the wavelength of light they absorb. In addition, these photoreceptors further transmit the signal through a cascade to modulate the expression of multiple genes that ultimately lead to physiological responses. (Wei et al., 2023)

Liu et al.(2021) explores how different light wavelengths (blue, green, and red) and intensities interact to affect photosynthesis. The classical view is that blue and red light drive photosynthesis more efficiently than green light because green is less absorbed. However, this study shows that green light penetrates deeper into the leaf and thus contributes effectively to photosynthesis, especially under high light conditions. When measured per absorbed light (quantum yield of absorbed light), red and green light were equally efficient, while blue light was slightly less so. The authors conclude that light quality and intensity interact synergistically rather than acting independently, emphasizing the need to consider green light in controlled-environment agriculture and LED design.

Huq (2024) provides a historical and conceptual overview of plant light signaling. It traces discoveries from the first identification of phytochromes in the 1950s to the modern understanding of complex photoreceptor networks. The review discusses how light perception triggers conformational and phosphorylation changes in photoreceptors, which then interact with transcription factors to modulate gene expression. It highlights the interplay between different photoreceptors (phytochromes, cryptochromes, phototropins, and UVR8) and their integration with hormonal and environmental signals. Huq concludes that plant light signaling is a multilayered system coordinating developmental and physiological responses to dynamic light environments.

Wu et al (2025) explores how light not only drives photosynthesis but also acts as a regulatory signal for carbohydrate metabolism. Light quality and intensity modulate the synthesis, transport, and utilization of sugars in plants. Through the action of phytochromes, cryptochromes, and phototropins, light regulates key metabolic enzymes and transcription factors. The study emphasizes cross-talk between light signaling and sugar signaling, showing how photosynthetic activity and sugar levels feed back to influence photomorphogenesis. The authors propose that controlling spectral light composition can optimize both yield and metabolic quality in crop systems.

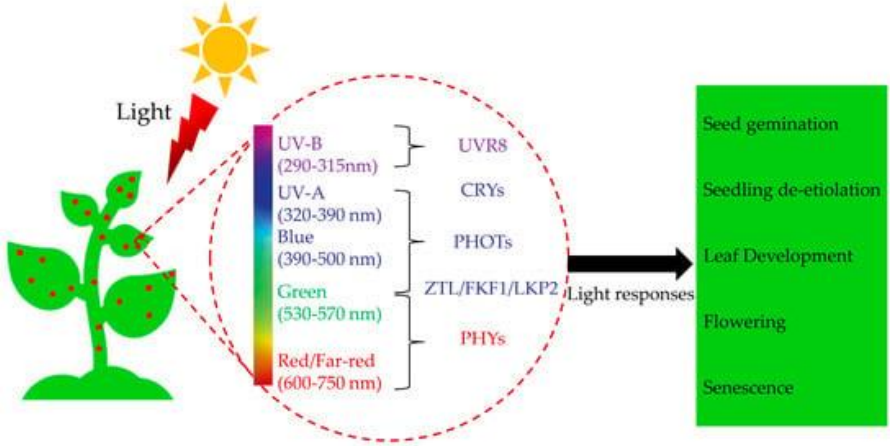

Figure 1. A schematic diagram depicting the involvement of light in different stages of photomorphogenesis
https://www.mdpi.com

MATERIALS AND METHODS

LED lamps were employed to investigate their potential in shortening the germination period and to assess their effects on early seedling development

1. The sowing was conducted during the period of January to February.
2. Two experimental conditions were established: a control group and a treatment group exposed to purple LED illumination. Both compartments—control and LED-treated—were maintained under identical environmental conditions, including temperature and relative humidity.
3. An equal number of seeds were sown for each treatment.

The growth substrate consisted of a homogeneous mixture of peat and perlite.

Figure 2. LED lamp

Figure 3. Exposing to purple LEDs

Figure 4 a-bChip budding grafting seedlins

Grafting period: April/May
Grafting method: Chip budding/T budding
We use one year old seedlings as rootstocks

RESULTS AND DISCUSSIONS

The germination period in 2019 for the control was between 54 and 70 days and for the led variant between 61 and 75 days

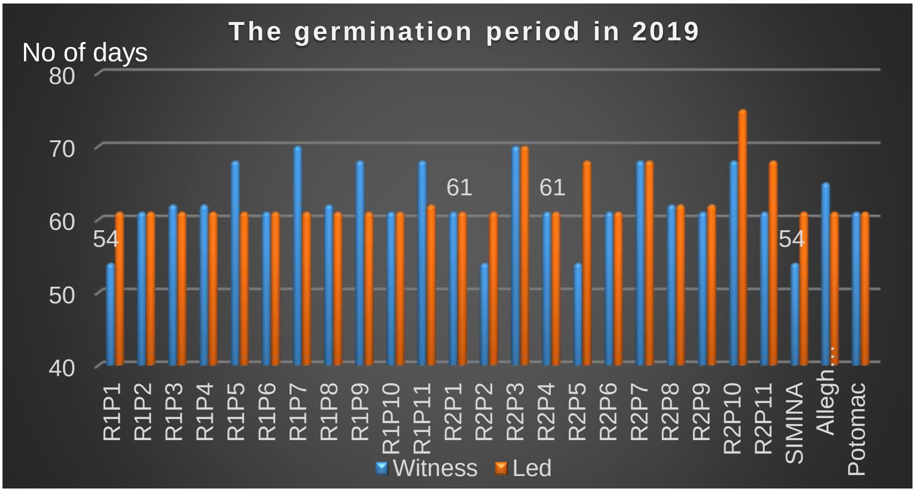

Figure 5. The germination period in 2019

The germination period in 2020 for the control was between 35 and 63 days and for the led variant between 41 and 78 days

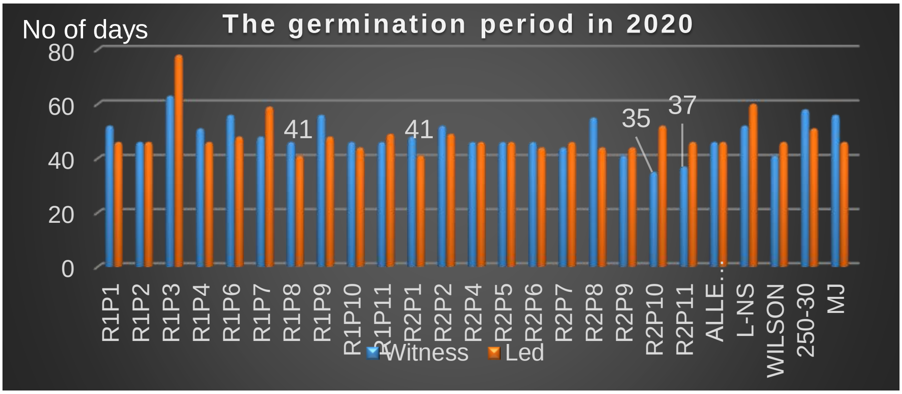

Figure 6. The germination period in 2020

In the 2 years of study, the average didn't differ very much between the variants. The shorter germination period in 2020 is due to the delay in sowing in February.

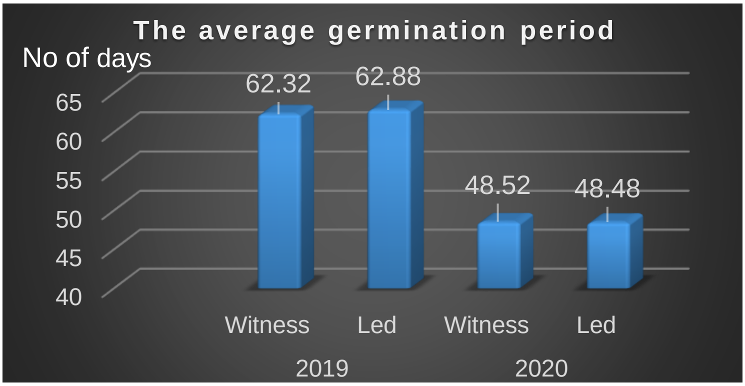

Figure 7. The avarage germination period

Comparison of the 2 years from the point of view of the germination period with the control version.

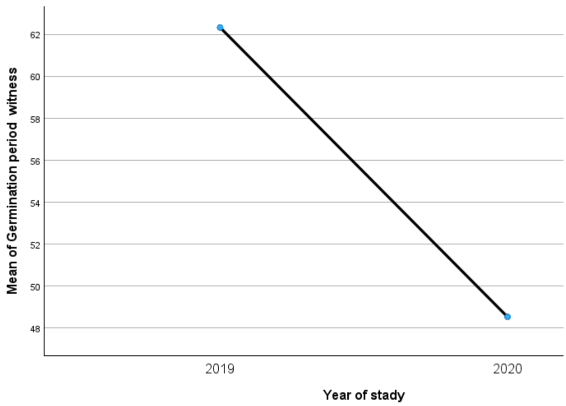

Figure 8. Mean of germination period witness

Comparison of the 2 years from the point of view of the germination period with the led version.

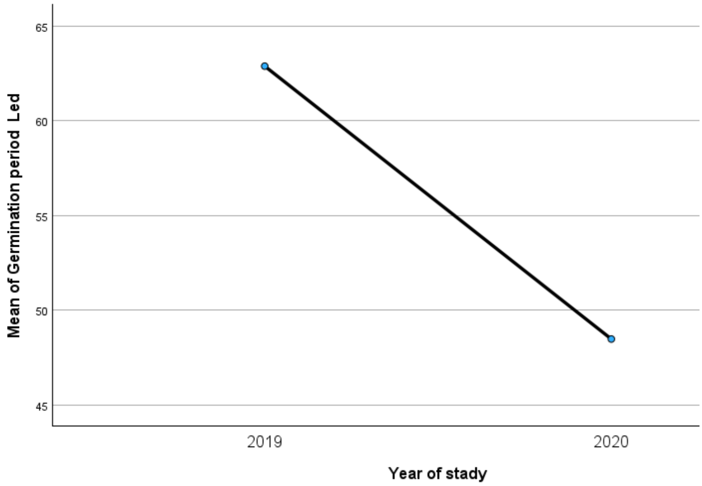

Figure 9. Mean of germination period LED

In 2019, we had between 70 and 100 percent germination for the control variant, depending on the seed genotypes, and for the leds, a percentage between 58 and 100.

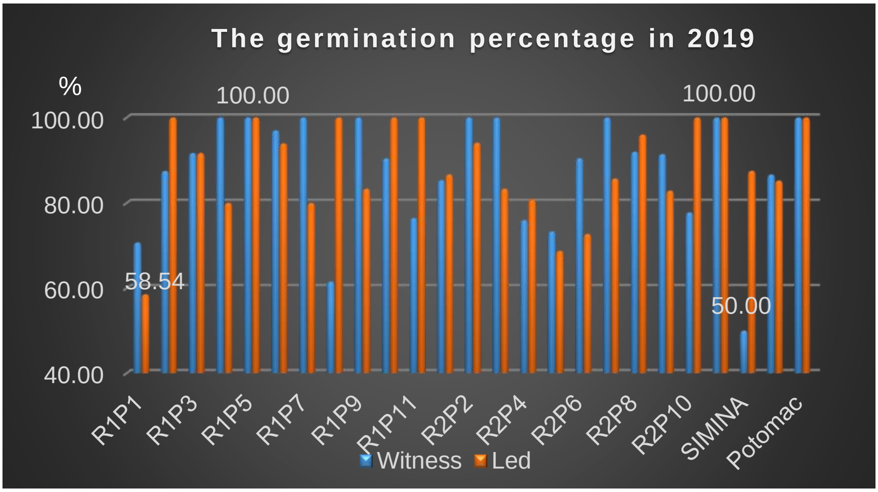

Figure 10. The germination percentage in 2019

In 2020, we had between 40 and 100 percent germination for the control variant, depending on the seed genotypes, and for the leds, a percentage between 0 and 100

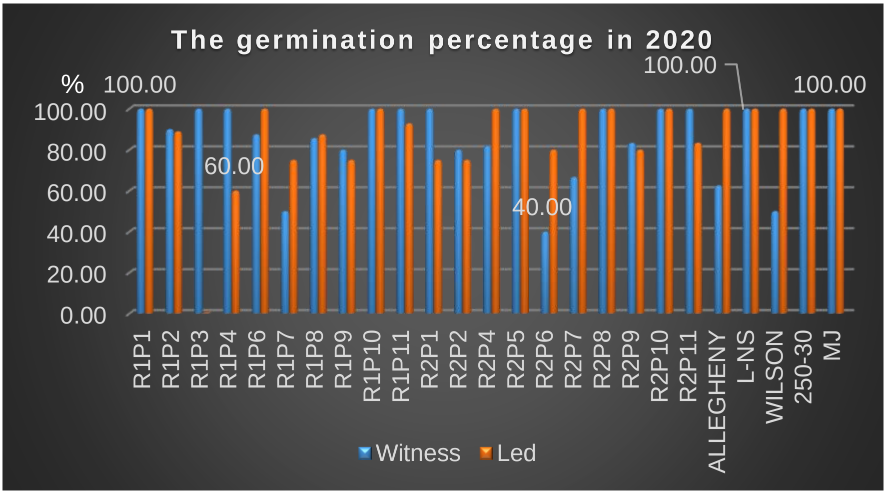

Figure 11. The germination percentage in 2020

In the 2 years of study, the germination percentage was between 86 and 88, being slightly higher every year in the led version

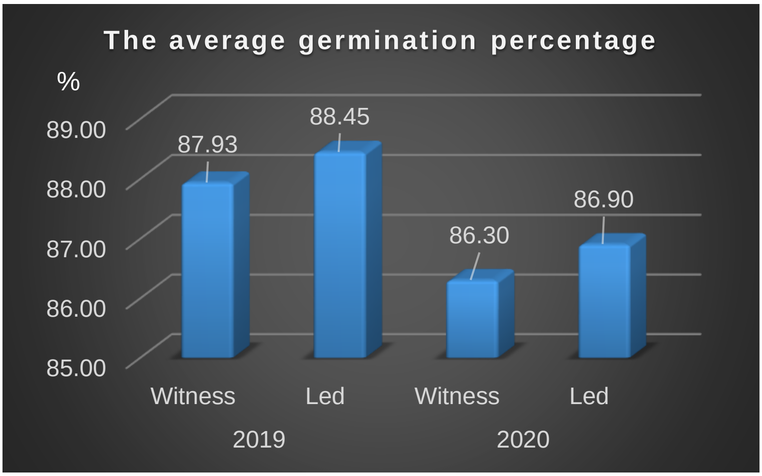

Figure 12. The avarage germination percentage

Comparison of the 2 years from the point of view of the germination percentage with the control version

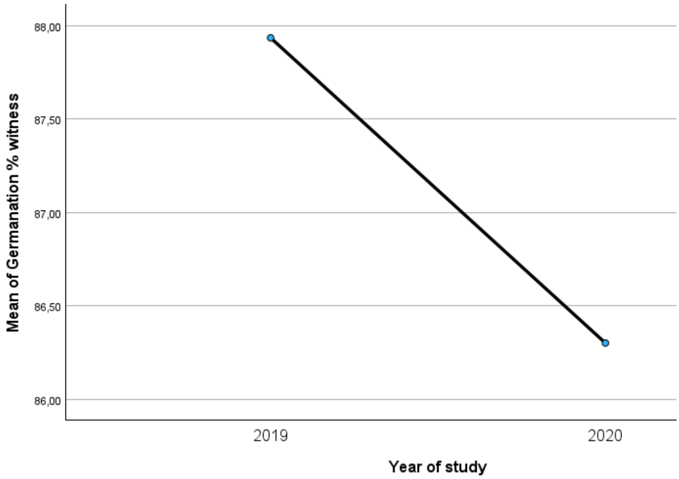

Figure 13. Mean of germination %withness

Comparison of the 2 years from the point of view of the germination percentage with the led version

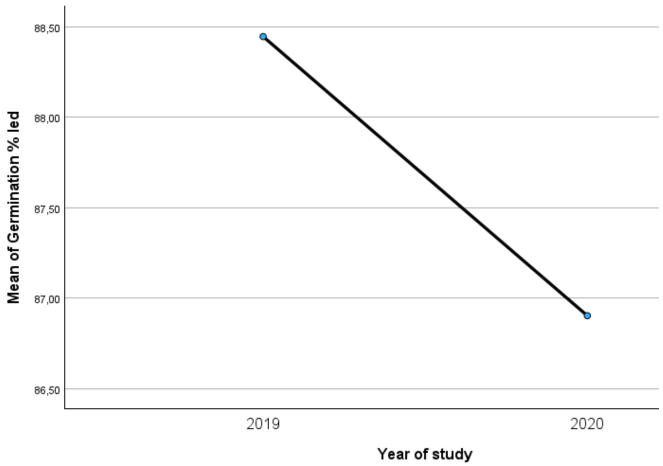

Figure 14. Mean og germination %LED

The plants were measured 4 months after sowing. The control version grew between 4 and 11 cm and the led version between 4 and 13 m

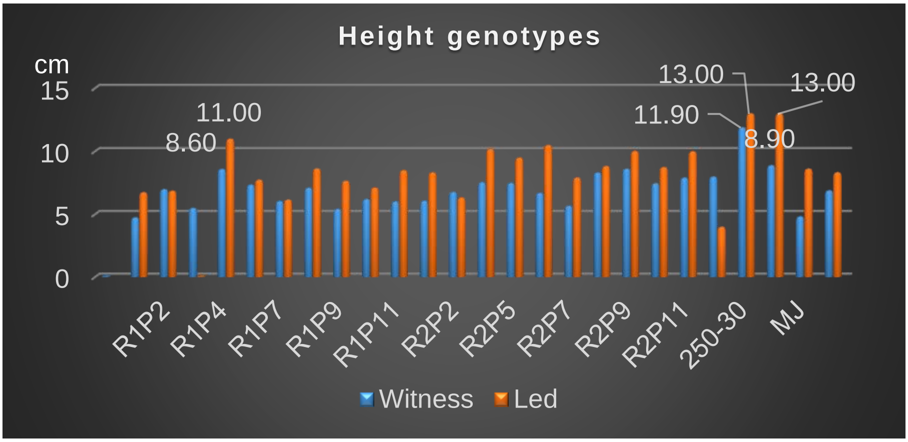

Figure 15. Height genotypes

At the time of the determinations, the genotypes in the control variant had between 1 and 6 leaves and the plants exposed to the LEDs had between 3 and 6 leaves.

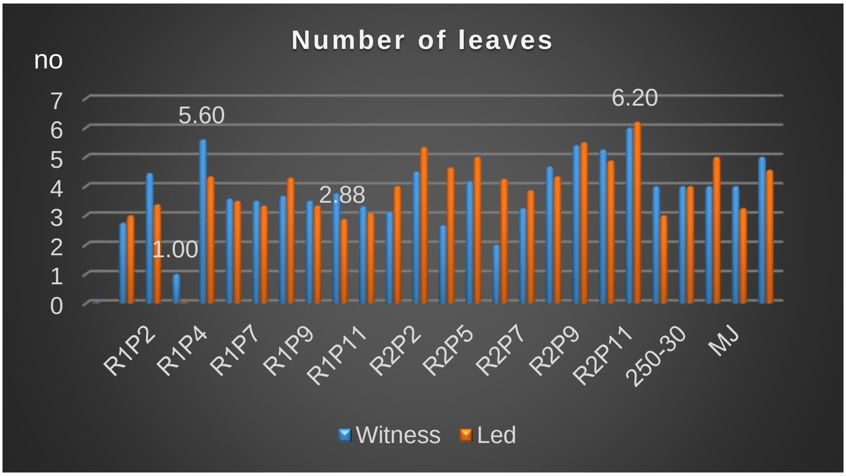

Figure 16. Number of leaves

The plants exposed to the lights had growth and a slightly higher number of leaves compared to the control cultivar

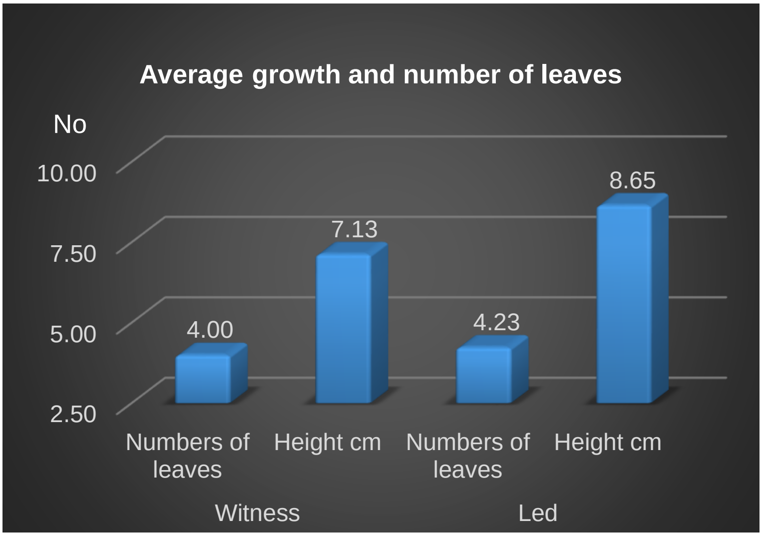

Figure 17. Average growth and number of leaves

Comparison of number of leaves between the control and variants where the plants were exposed to LEDs

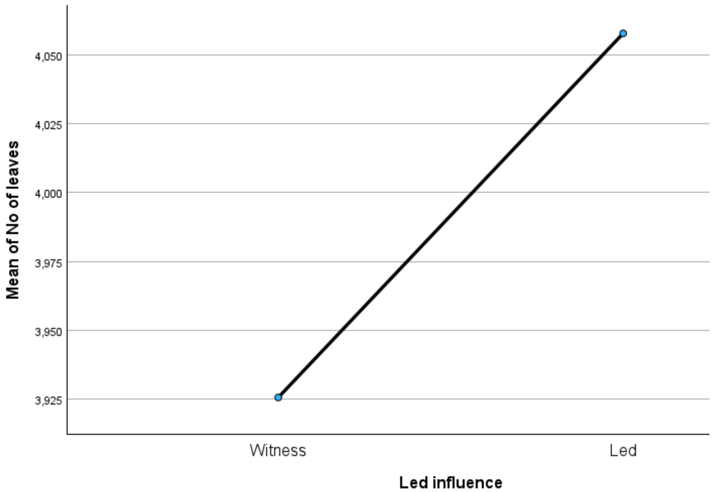

Figure 18. Mean of number of leaves

Comparison of height between the control and variants where the plants were exposed to LEDs

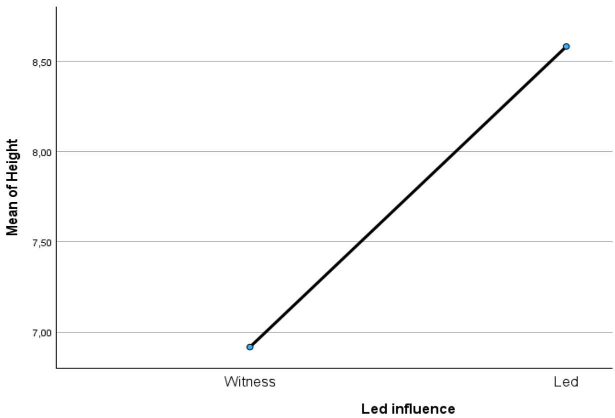

Figure 19. Mean of height

The grafted plants in the second year of growth had a number of branches between 6 and 1

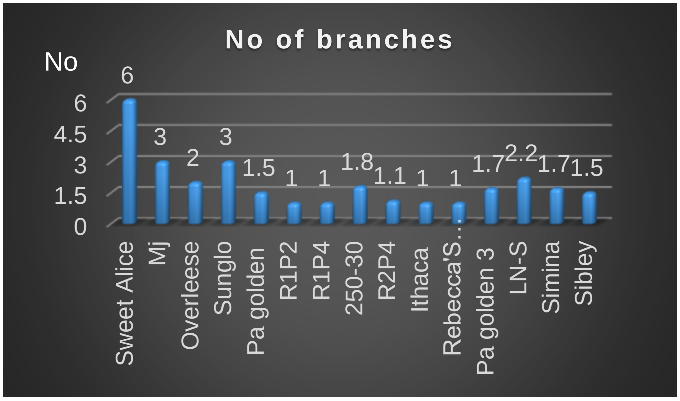

Figure 20. Number of branches

The plants had average growth between 22 and 47 cm

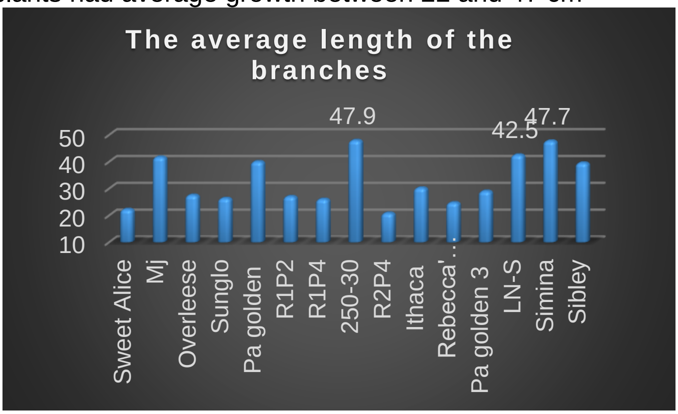

Figure 21. The average length of the branches

CONCLUSIONS

The findings of this study demonstrate that Asimina triloba can be successfully propagated under controlled environmental conditions using both generative and vegetative methods. Although LED illumination did not significantly reduce germination time, it contributed to slightly improved uniformity and early vegetative development, reflected by increased seedling height and leaf number. These results suggest that spectral light manipulation may play a supportive role in optimizing early growth stages, particularly for enhancing the physiological quality of seedlings intended for grafting. Furthermore, the grafting trials confirmed that both chip budding and T-budding techniques, applied during April–May on one-year-old rootstocks, ensure high compatibility and vigorous post-graft development. The combination of carefully timed grafting and healthy seedling rootstocks provides a reliable pathway for the clonal propagation and preservation of superior genotypes. Overall, this integrated propagation approach — combining controlled-environment seedling production with precise vegetative grafting — represents an effective and sustainable strategy for the establishment of Asimina triloba orchards in temperate European regions, thereby supporting the species' adaptation, genetic conservation, and commercial potential.

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REFERENCES

Bellini E., Montanari D., 1992, La coltura dell'Asimina in Italia experienze mature a Foenza, L'informatore Agrario

Cepoiu N., Dănăilă-Guidea S. M., Burzo I., Roșu A., Margarit C. și Păun C., 2004, Morpho-Productive Particularities of Local Population (PGO) of Asimina triloba L. Dunal, from Romania, În: Lucrări științifice U.S.A.M.V.B., Seria B, Vol. XLVII

Cothron B., 2021, Pawpaws The Complete Growing and Marketing Guide, New Society Publishers

Geneve, R. L., Kester, S. T., & Pomper, K. W., 2007, Cytokinin habituation for autonomous shoot initiation in pawpaw (Acta Horticulturae 738).

https://www.mdpi.co

Huq, E., Lin, C., & Quail, P. H. 2024. Light signaling in plants — a selective history. Plant Physiology, 195(1), 213-231.

Layne, D. R., & Whitmore, R. C. 2019. Comparison of Grafting and Budding Propagation Techniques for Cultivars of the North American Pawpaw. HortTechnology, 34(6).

Liu, J., & van Iersel, M. W. 2021. Photosynthetic Physiology of Blue, Green, and Red Light: Light Intensity Effects and Underlying Mechanisms. Frontiers in Plant Science, 12, Article 619987.

Stănică F., 2012, Asimina triloba (pawpaw) germplasm in Romania, Scientific Papers, Series B. Horticulture, Vol. LVI, print ISSN 2285-5653

Stănică F., M. Dumitrașcu, V. Dumitrescu, R. Madjar și A. Pericila, 2002, Înmulțirea plantelor horticole lemnoase, editura Ceres, Bucuești

Wei Y.,Wang S., Yu D., 2023, The Role of Light Quality in Regulating Early Seedling Development Plants, 2746.

Wu, W., Chen, L., Liang, R., Huang, S., Li, X., Huang, B., Luo, H., Zhang, M., Wang, X., & Zhu, H. 2025. The role of light in regulating plant growth, development and sugar metabolism: a review. Frontiers in Plant Science, 15, Article 1507628.