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Obtaining Potato Minitubers Using Aeroponic Methods under Artificial Conditions Across Different Cultivation Periods

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ABSTRACT

Potato minitubers are a critical starting material for high-quality seed production, and aeroponic culture offers a controlled environment to enhance uniformity, growth, and yield. In 2025, minituber production was conducted using the aeroponic method under fully controlled conditions. A bifactorial experiment tested cultivation period (winter-spring as control, and summer-autumn) and potato variety (Azaria, Brașovia, Cosiana, and Cezarina as control). In vitro plantlets were transferred to the aeroponic system in two period: January and June. Plant height and root length were recorded 1 and 2 months after transfer and sequential harvests evaluated minituber number and weight (>15 mm). Data were analyzed via ANOVA. Variety strongly influenced vegetative growth and root development, with Cosiana achieving the greatest height and root length across all periods. Cultivation period influenced both plant height and minituberization, with summer-autumn cultures yielding higher growth and greater minituber number and weight. Cosiana and Brașovia demonstrated high vegetative vigor, stable minituber production, and superior adaptability to aeroponic conditions. The aeroponic method proved effective for minituber production, and selecting high-performing varieties combined with optimal cultivation periods is essential to maximize biological and productive potential.

Keywords: potato, vitroplants, aeroponic culture, cultivation period, minitubers.

INTRODUCTION

According to Sinha et al. (2025) due to the growing demand of the rising population and changing lifestyle, we have to produce more potatoes which is not possible by conventional cultivation of potatoes, and one of the major bottlenecks in potato production is the unavailability of high-quality and certified seed potatoes because potato is propagated through tuber which is highly susceptible to infestation of several diseases and the chance of infestation become more when tuber comes in contact to soil. Thus, there is a need or time to revolutionize or advance potato seed production which is possible using innovative technology, i.e., aeroponic. These systems save time, land, fertilizer, and water in an environment-friendly manner and give higher and uniform yields as compared to the conventional method.

Aeroponics is a modern, soilless technology for the production of minitubers. In the aeroponic cultivation system, the underground parts (roots and underground stems) of potato plants are situated in a dark chamber, called the module, suspended in the air, and supplied with water and nutrients through a nutrient solution dispersed in the form of fine fog particles (Broćić et al., 2021). Aeroponic system has the potential to make seed potato production more efficient as the unit production of mini-tubers is increased to an average of 35 from 5 (Ngawang and Dochen, 2014). Aeroponics is introduced as an option for rapid seed multiplication method in order to revamp the formal seed potato production system (Ngawang and Dochen, 2013).

Čížek and Komárková (2022) made a comparasion of potato minitubers production through aeroponic method compared to the classic one. The number of tubers per plant in aeroponic units ranged from 2.4 (2019, cv. Adéla) to 41.0 (2021, cv. Zuza), while in the greenhouse, they ranged from 3.9 (2019, cv. Adéla) up to 12.6 (2021, cv. Adéla). Rykaczewska (2016) obtaines an average of 32.5-36.0 minitubers per plant. In other study

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(Broćić et al., 2019) an average of 17.87 mini tubers was obtained in aeroponics system, which is 5.39 times more than in the conventional substrate. Depending on variety and planted material origin in aeroponic culture, Broćić et al. (2022) reported a minimum mean number of 6.25 minitubers/plants (starting from *in vitro* material) for the Cleopatra variety and a maximum number of 54.50 minitubers/plant (from *in vitro* material) for Agria variety. In aeroponic experiments with beneficial microorganisms, production reached 18.4 minitubers/plant (Hartinger et al., 2025). The amount of minitubers per plant produced in aeroponic cultivation is much higher than in conventional soil cultivation. Wasilewska-Nascimento et al. (2020) mention that can be achieve approximately 50-100 minitubers per plant, compared to 5-10, which is characteristic for soil production (Otazu, 2010 and Mbiyu et. al., 2012, quoted by Wasilewska-Nascimento et al., 2020); also, using aeroponics, potato plants can yield up to 250-300 minitubers per plant (Terent'yeva and Tkachenko, 2018, quoted by Wasilewska-Nascimento et al., 2020).

Previous results in Romania on the production of potato minitubers in soilless systems have been reported in studies conducted in hydroponic culture. Tican (2018) and Tican et al. (2018a) highlighted the efficiency of hydroponic systems in multiplying seed material, obtaining high values of minitubers number/plant. The application of hydroponic systems such as NFT and the Wilma system, on substrates such as perlite or expanded clay, has led to superior results in the minituberization process compared to conventional methods Tican (2018). Similar results were later confirmed by Tican et al. (2025), demonstrating the potential of soilless systems for the rapid production of minitubers. The maximum number obtained/plant in 2025 was for the Azaria variety on the NFT system (Tican et al., 2025).

In Romania, studies on aeroponic systems were also carried out in 2018, at NIRDPSB Brașov, at different densities (Tican et al., 2018b). In 2025, a new, more efficient system was developed, without using any type of substrate, resulting in a significant increases in the number of minitubers, achieving a maximum of 48 minitubers/plant exceeding 15 mm in diameter.

MATERIAL AND METHODS

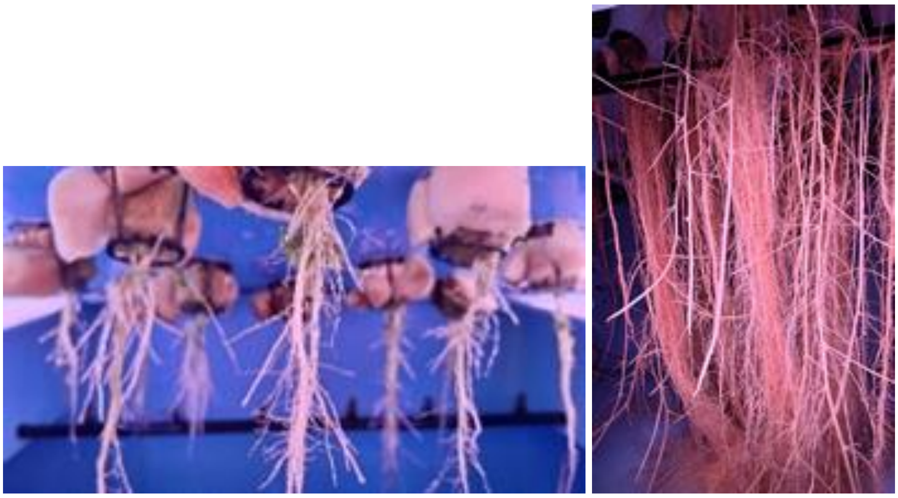
In 2025, the aeroponic method for producing minitubers under fully controlled conditions was applied. The aeroponic system was specifically designed for potato cultivation and a patent application is currently being subitted by NIRDPSB Brașov. In the same year, a bifactorial experiment was carried out, in which the factor *a* was represented by the cultivation period, with 2 levels: winter-spring (taken as control) and summer-autumn, while factor *b* represented variety, with 4 levels: Azaria, Brașovia, Cosiana and Cezarina (considered control). Plant height and root system length were measured 1 month and 2 months after transfering the in vitroplantlets to the aeroponic system.

At the beginning of 2025, in January, the biological material obtained *in vitro* (vitroplants) was transferred directly into the aeroponic system. Several sequential harvests were carried ou, and the last harvest was in May. Each in vitro plantlet was placed in a Grodan cube made of mineral wool, and a 50 mm diameter basket was used individually as a support structure. To prevent light penetration into the module, the plants were wrapped with sponges (Figure 1) and fixed to the upper part of the aeroponic module. The second transfer of the vitroplants occured in June, and the last harvest took place in October. Figure 2 shows images illustrating the **development** of the root system.

Both at first and second planting, plant development took place under controlled conditions, with the following parameters automatically monitored: electroconductivity of the nutrient solution (2.0 mS/cm), pH of the solution, temperature of the nutrient solution (17-18°C), room temperature (maintaining a constant room temperature of 18-20°C during the day and 16-18°C at night), the atomization frequency, the spraying time and the atomization interval. The nutrient solution was supplied by alternation: administration by atomization for 20 seconds, then a 10 minute interruption. Plants grown in the aeroponic system benefited from a photoperiod comprising 16 h of light, in order not to create a large difference between *in vitro* and *ex vitro,* and along way, the illumination period was reduced to 12 h to determine the initiation of minituberization process.

After completing the sequential harvests, analyses of number and weight of minitubers (Figure 3) were performed. The statistical calculation was performed for minitubers larger than 15 mm using the ANOVA program.

Figure 1. Plant transferred to aeroponic system



a) **b)**

Figure 2. Roots development: first week (a) and 1 month after transfer (b)

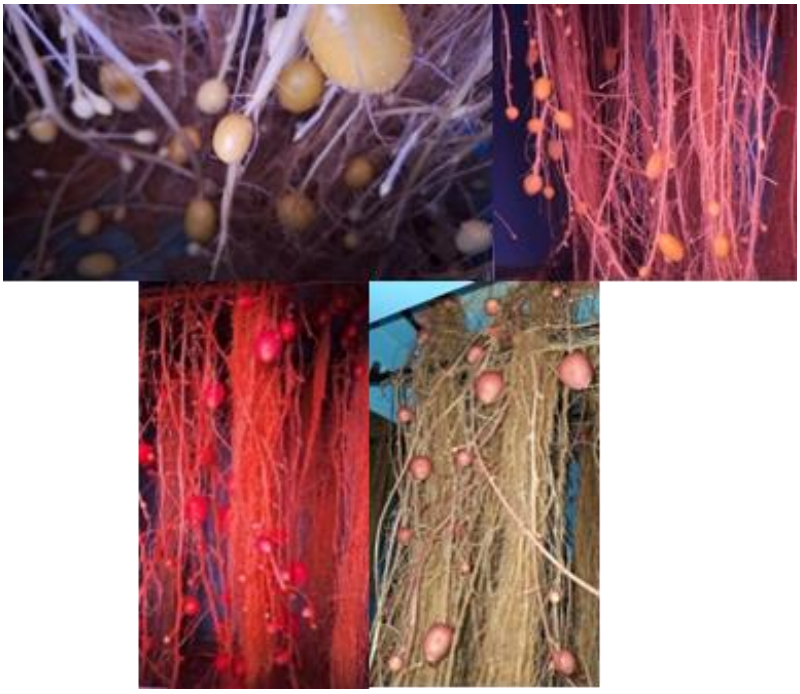


Figure 3. Minitubers obtain by aeroponic culture

RESULTS AND DISCUSSION

Tables 1 and 2 highlight the significant influence of variety and the interaction between variety and cultivation period on plant height and root length at 1 month after transfer to the aeroponic system, with a significance level of p ≤ 0.01. Both variety, period and the interaction between variety and cultivation period had a significant influence on plant height and root length, at a probability level of 1%, 2 months after transfer. 1 month after transfer, there were no significant differences between cultivation periods for plant height and root length (Table 3).

1 month after transfer (Table 4), Cosiana variety showed a very good evolution for plant height (23.20 cm), significantly differentiating from the other varieties. Regarding root length, Brașovia and Cosiana varieties recorded the highest values (64.40 and 61.71 cm), significantly differentiating positively from the control variety, followed by the Azaria variety (52.60 cm).

Table 1. Analysis of variance (NIRDPSB Brașov, 2025)

Cause of variability	Sum of squares	DF	Mean square	F-value
Analysis of variance for plant height, 1 month after transfer				
Cultivation period (a)	0.75	1	0.75	0.12 ns (18.51; 98.50)
Variety (b)	396.70	3	132.23	50.69 ** (3.49; 5.95)
Cultivation period (a) * Variety (b)	76.43	3	25.48	9.77 ** (3.49; 5.95)
Analysis of variance for plant height 2 months after transfer				
Cultivation period (a)	3493.54	1	3493.54	120.02 ** (18.51; 98.50)
Variety (b)	6825.38	3	2275.13	87.17 ** (3.49; 5.95)
Cultivation period (a) * Variety (b)	586.90	3	195.63	7.50 ** (3.49; 5.95)

DF Degrees of freedom; ** significant for p < 1%; ns not significant for p < 5%.

Table 2. Analysis of variance (NIRDPSB Braşov, 2025)

Cause of variability	Sum of squares	DF	The mean square	F-value
Analysis of variance for root length 1 month after transfer				
Cultivation period (a)	0.31	1	0.31	0.003 ns (18.51; 98.50)
Variety (b)	1660.41	3	553.47	34.59 ** (3.49; 5.95)
Cultivation period (a) * Variety (b)	409.20	3	136.40	8.53 ** (3.49; 5.95)
Analysis of variance for root length 2 months after transfer				
Cultivation period (a)	2030.81	1	2030.81	5.04 ** (18.51; 98.50)
Variety (b)	4267.06	3	1422.35	55.88 ** (3.49; 5.95)
Cultivation period (a) * Variety (b)	1570.71	3	523.60	20.57 ** (3.49; 5.95)

DF Degrees of freedom; ** significant for $p < 1\%$; ns not significant for $p < 5\%$.

Table 3. Influence of cultivation period on plant height (cm) and root length (cm) 1 month after transfer to aeroponic system (NIRDPSB Braşov, 2025)

Cultivation period (a)	Plant height (cm)	Diff. (cm)/ Sign.	Root length (cm)	Diff. (cm)/ Sign.
Winter-spring (a_1) (Ct)	18.48 A		55.37 A	-
Summer-autumn (a_2)	18.12 A	-0.35 ns	55.60 A	0.23 ns

LSD (p 5%) = 4.45; (p 1%) = 10.27; (p 0.1%) = 32.69. | LSD (p 5%) = 16.90; (p 1%) = 39.02; (p 0.1%) = 124.16.

Means that are in the same columns, followed by the same letters, do not differ significantly, according to Duncan's test ($p < 0.05$).

Table 4. Influence of variety on plant height (cm) and root length (cm) 1 month after transfer to aeroponic system (NIRDPSB Braşov, 2025)

Variety (b)	Plant height (cm)	Diff. (cm)/ Sign.	Root length (cm)	Diff. (cm)/ Sign.
Azaria (b_1)	16.89 A	4.46 ***	52.60 B	9.37 **
Brașovia (b_2)	20.68	8.25 ***	64.40 A	21.17 ***
Cosiana (b_3)	23.20	10.77 ***	61.71 A	18.48 ***
Cezarina (b_4) (Ct)	12.43 A	-	43.23 C	

LSD (p 5%) = 2.03; (p 1%) = 2.85; (p 0.1%) = 4.03. | LSD (p 5%) = 5.03; (p 1%) = 7.07; (p 0.1%) = 9.98.

Table 5. Combined influence of cultivation period and variety on plant height (cm) 1 month after transfer to aeroponic system (NIRDPSB Brașov, 2025)

Cultivation period (a)/ Variety (b)	Winter-spring (a_1)		Summer-autumn (a_2)		a_2-a_1 (cm)/ Sign.
	Plant height (cm)	Diff. (cm)/ Sign.	Plant height (cm)	Diff. (cm)/ Sign.	
Azaria (b_1)	17.78	7.55 ***	16	1.36 ns	-1.78 ns
Brașovia (b_2)	20.08	9.86 ***	21.27	6.63 ***	1.18 ns
Cosiana (b_3)	25.82	15.60 ***	20.58	5.95 ***	-5.24 ns
Cezarina (b_4) (Ct)	10.22	-	14.64		4.41 ns

LSD (p 5%) = 2.87; (p 1%) = 4.04; (p 0.1%) = 5.70.　　LSD (5%) = 4.83; (p 1%) = 9.49; (p 0.1%) = 25.61.

During the winter-spring period, plant height varied between 10.22 cm for control variety Cezarina and 25.82 cm for Cosiana variety. All analyzed varieties (Azaria, Brașovia and Cosiana) recorded significantly higher height values compared to the control, the differences being highly statistically significant ($p < 0.001$), exceeding the corresponding LSD thresholds. These results indicate a pronounced effect of the genetic factor on vegetative growth during this period.

During the summer-autumn period, the average plant height values ranged between 14.64 cm (Cezarina) and 21.27 cm (Brașovia). Brașovia and Cosiana varieties presented very significant positive differences, statistically assured ($p < 0.001$) compared to the control, while the Azaria variety did not register significant differences. The aeroponic system ensured a relative stability of growth, regardless of the season.

The variety was the main determining factor of plant height in the aeroponic system (Table 5). Cosiana variety stood out with the highest values, especially in the winter-spring period (25.82 cm).

During winter-spring period (Table 6), Brașovia and Cosiana varieties recorded very significant positive differences (27.19 and 14.28 cm), which highlights a high potential for root system development during this period, compared to control variety. Azaria variety (49.08 cm) presented a higher root length value compared to control, but the difference was not statistically significant.

During summer-autumn period, all analyzed varieties presented values superior to control, the differences being distinctly significant (13.29 cm) for Azaria and very significant for Brașovia (15.15 cm) and Cosiana (22.68 cm). These results indicate a stimulation of the root system growth in summer–autumn conditions, especially for Brașovia and Cosiana varieties (Table 6). Comparison of cultivation periods showed that differences between seasons were not statistically significant for any variety.

Table 6. Combined influence of cultivation period and variety on root length (cm) 1 month after transfer to aeroponic system (NIRDPSB Brașov, 2025)

Cultivation period (a)/ Variety (b)	Winter-spring (a_1)		Summer-autumn (a_2)		a_2-a_1 (cm)/ Sign.
	Root length (cm)	Diff. (cm)/ Sign.	Root length (cm)	Diff. (cm)/ Sign.	
Azaria (b_1)	49.08	5.44 ns	56.11	13.29 **	7.03 ns
Brașovia (b_2)	70.83	27.19 ***	57.97	15.15 ***	-12.86 ns
Cosiana (b_3)	57.92	14.28 ***	65.50	22.68 ***	7.58 ns
Cezarina (b_4) (Ct)	43.64	-	42.82	-	-0.82 ns

LSD (p 5%) = 7.12; (p 1%) = 9.99; (p 0.1%) = 14.11.
LSD (5%) = 17.31; (p 1%) = 36.72; (p 0.1%) = 107.91.

Table 7. Influence of the cultivation period on plant height (cm) and root length (cm) 2 months after transfer to aeroponic system (NIRDPSB Brașov, 2025)

Cultivation period (a)	Plant height (cm)	Diff. (cm)/ Sign.	Root length (cm)	Diff. (cm)/ Sign.
Winter-spring (a_1) (ct)	65.64 B	-	81.19 A	-
Summer-autumn (a_2)	89.77 A	24.13 **	99.58 A	18.39 ns

LSD (p 5%) = 9.47; (p 1%) = 21.87; (p 0.1%) = 69.60.
LSD (p 5%) = 35.25; (p 1%) = 81.41; (p 0.1%) = 259.07.

Means that are in the same columns, followed by the same letters, do not differ significantly, according to Duncan's test ($p < 0.05$).

Table 8. Influence of variety on plant height (cm) and root length (cm) 2 months after transfer to aeroponic system (NIRDPSB Brașov, 2025)

Variety (b)	Plant height (cm)	Diff. (cm)/ Sign.	Root length (cm)	Diff. (cm)/ Sign.
Azaria (b_1)	73.38 B	21.21 ***	92.42 B	23.72 ***
Brașovia (b_2)	89.47 A	37.30 ***	95.56 B	26.86 ***
Cosiana (b_3)	95.82 A	43.65 ***	104.87 A	36.17 ***
Cezarina (b_4) (Ct)	52.17 C	-	68.70 C	-

LSD (p 5%) = 6.43; (p 1%) = 9.03; (p 0.1%) = 12.74.
LSD (p 5%) = 6.35; (p 1%) = 8.91; (p 0.1%) = 12.58.

Table 9. Combined influence of cultivation period and variety on plant height (cm) 2 months after transfer to aeroponic system (NIRDPSB Brașov, 2025)

Cultivation period (a)/ Variety (b)	Winter-spring (a_1)		Summer-autumn (a_2)		a_2-a_1 (cm)/ Sign.
	Plant height (cm)	Diff. (cm)/ Sign.	Plant height (cm)	Diff. (cm)/ Sign.	
Azaria (b_1)	66.08	21.08 ***	80.67	21.34 ***	14.59 *
Brașovia (b_2)	71.11	26.11 ***	107.83	48.50 ***	36.72 **
Cosiana (b_3)	80.38	35.38 ***	111.26	51.93 ***	30.88 **
Cezarina (b_4) (Ct)	45.00	-	59.33		14.33 *

LSD (p 5%) = 9.09; (p 1%) = 12.76; (p 0.1%) = 18.02.
LSD (5%) = 11.65; (p 1%) = 20.82; (p 0.1%) = 49.56.

In the summer-autumn period, the plants recorded a significantly higher average height (89.77 cm), the distinctly significant positive difference between the 2 periods, recording a value of 24.13 cm. A favorable effect of the summer–autumn period on vegetative growth in height can be observed 2 months after transfer (Table 7).

Root length was not significantly influenced by the cultivation period, indicating greater stability of root system development in relation to cultivation periods.

All analyzed varieties (Cosiana, Brașovia and Azaria) recorded higher height values compared to the control, the differences being very statistically significant (43.65 cm; 37.30 cm and 21.21 cm). Regarding the length of the roots, the superiority of Cosiana variety is noted in forming a well-developed root system (104.87 cm), differing very significantly from the control (36.17 cm), followed by Brașovia (95.56 cm) and Azaria (92.42 cm) varieties, also with very significant positive differences compared to the Cezarina variety (Table 8).

2 months after transfer, Cosiana variety presented plants with well-developed stems, regardless of the growing season, followed by Brașovia and Azaria (Table 9).

The analysis of differences between cultivation periods suggests that all varieties responded positively to summer-autumn period conditions, the differences being distinctly statistically significant for the Brașovia (36.72 cm) and Cosiana (30.88 cm) varieties and significant (Azaria and Cezarina).

Regarding root length, 2 months after transfer, Cosiana variety stands out, which had the ability to form a very well-developed root system, regardless of the cultivation season, followed by Brașovia and Azaria. In the winter-spring period, Cosiana variety adapted best, registering a very significant positive difference compared to the control (17.91 cm). In the summer-autumn period, Cosiana (54.44 cm), Brașovia (45.55 cm) and Azaria (42.78 cm) varieties presented very significant positive differences compared to the control (Table 10). The cultivation period did not determine statistically significant variations

Statistical analysis was performed on minitubers number and their weight, but for minitubers larger than 15 mm.

Table 11 indicates that growing season had a statistically significant effect ($p < 0.05$) on minitubers number per plant, with the calculated F value ($F = 34.64$) exceeding the corresponding critical value. This result highlights the influence of seasonal conditions on the minituberization process.

The variety factor exerted a highly statistically significant effect ($p < 0.01$), with a high F value ($F = 96.61$), demonstrating that genetic differences between varieties represent the main source of variation for this production trait.

Also, the interaction between cultivation period and variety was highly statistically significant ($p < 0.01$).

In case of minituber weight per plant, the cultivation period also had a statistically significant effect ($p < 0.05$). The result suggests that the accumulation of biomass for minitubers was influenced by the cultivation period.

The variety factor had a very statistically significant impact ($p < 0.01$) on minituber weight.

The cultivation period × variety interaction was also statistically significant ($p < 0.05$), indicating that the influence of crop period on minituber weight differs depending on the variety, highlighting the need to adapt the genetic material to specific culture conditions.

The summer-autumn crop period determined significant increases in both the number and weight of minitubers/plant, compared to the winter-spring period (Table 12).

The highest values of minitubers number were obtained for varieties Cosiana (42.28 minitubers/plant) and Brașovia (39.18 minitubers/plant), classified in the same statistical significance group, according to Duncan's test, which indicates the lack of significant differences between them (Table 13). Compared to the control, all other varieties recorded very significant differences ($p < 0.001$), exceeding the LSD values corresponding to all significance thresholds, which highlights the major influence of variety on capacity of minituber formation.

The same trend was observed for minitubers weight /plant. The highest values were obtained for Cosiana (477.87 g) and Brașovia (437.33 g) varieties. The differences between varieties and control were very significant (438.69 g; 398.15 g and 291.48 g) ($p < 0.001$), confirming Cosiana, Brașovia and Azaria superiority.

For Azaria variety, mean number of minitubers increased from 21.06 minitubers/plant in the winter-spring cultivation to 45.89 minitubers/plant in the summer-autumn period (Table 14), the difference of 24.83 minitubers/plant being distinctly significant ($p < 0.01$).

A similar behavior was observed for Cosiana variety, where minitubers number increased from 35.95 minitubers/plant in the first half of the year to 48.61 minitubers/plant in the second half of the year, the difference of 12.66 minitubers/plant also being significant ($p < 0.05$).

In contrast, for control variety Cezarina, the difference between the two cultivation periods was statistically insignificant (-0.61 minitubers/plant), indicating a reduced reaction to the change in crop season.

Table 10. Combined influence of cultivation period and variety on root length (cm) 2 months after transfer to aeroponic system (NIRDPSB Braşov, 2025)

Cultivation period (a)/ Variety (b)	Winter-spring (a_1)		Summer-autumn (a_2)		a_2-a_1 (cm)/ Sign.
	Root length (cm)	Diff. (cm)/ Sign.	Root length (cm)	Diff. (cm)/ Sign.	
Azaria (b_1)	78.17	4.67 ns	106.67	42.78 ***	28.50 ns
Brașovia (b_2)	81.67	8.17 ns	109.44	45.55 ***	27.77 ns
Cosiana (b_3)	91.41	17.91 ***	118.33	54.44 ***	26.92 ns
Cezarina (b_4) (Ct)	73.50	-	63.89	-	-9.61 ns

LSD (p 5%) = 8.98; (p 1%) = 12.61; (p 0.1%) = 17.80.

LSD (5%) = 35.43; (p 1%) = 79.01; (p 0.1%) = 243.71.

Table 11. Analysis of variance (NIRDPSB Brașov, 2025)

Cause of variability	Sum of squares	DF	The mean square	F-value
Analysis of variance for the number of minitubers/plant				
Cultivation period (a)	1169.85	1	1169.85	34.64 * (18.51; 98.50)
Variety (b)	4881.27	3	1627.09	96.61 ** (3.49; 5.95)
Cultivation period (a) * Variety (b)	536.07	3	178.69	10.61 ** (3.49; 5.95)
Analysis of variance for minituber weight/plant				
Cultivation period (a)	30849.530	1	30849.53	31.47 * (18.51; 98.50)
Variety (b)	705939.00	3	235313.00	110.425** (3.49; 5.95)
Cultivation period (a) * Variety (b)	26899.34	3	8966.45	4.21* (3.49; 5.95)

DF Degrees of freedom; * significant for $p < 5\%$; ** significant for $p < 1\%$.

Table 12. Influence of the growing season on the number of minitubers and their weight (g)/plant (NIRDPSB Brașov, 2025)

Cultivation period (a)	Minitubers number/pl.	Diff./ Sign.	Minitubers weight/pl. (g)	Diff. (g)/ Sign.
Winter-spring (a_1) (ct)	23.30 B	-	285.41 B	-
Summer-autumn (a_2)	37.26 A	13.96 *	357.11 A	71.70 *

LSD (p 5%) = 10.20; (p 1%) = 23.56; (p 0.1%) = 74.97. LSD (p 5%) = 54.96 g; (p 1%) = 126.93 g; (p 0.1%) = 403.92 g.

Means that are in the same columns, followed by the same letters, do not differ significantly, according to Duncan's test ($p < 0.05$).

Table 13. Influence of variety on the number of minitubers and their weight (g)/plant (NIRDPSB Brașov, 2025)

Variety (b)	Minitubers number/pl.	Diff./ Sign.	Minitubers weight/pl. (g)	Diff. (g)/Sign.
Azaria (b_1)	33.47 B	27.28 ***	330.66 B	291.48 ***
Brașovia (b_2)	39.18 A	32.99 ***	437.33 A	398.15 ***
Cosiana (b_3)	42.28 A	36.09 ***	477.87 A	438.69 ***
Cezarina (b_4) (Ct)	6.19 C	-	39.18 C	-

LSD (p 5%) = 5.17; (p 1%) = 7.25; (p 0.1%) = 10.24. LSD (p 5%) = 58.10 g; (p 1%) = 81.55 g; (p 0.1%) = 115.14 g.

Means that are in the same columns, followed by the same letters, do not differ significantly, according to Duncan's test ($p < 0.05$).

Tabelul 14. Combined influence of growing season and variety on the average number of minitubers/plant (NIRDPSB Brașov, 2025)

Cultivation period (a)/ Variety (b)	Winter-spring (a_1)		Summer-autumn (a_2)		a_2-a_1 (cm)/ Sign.
	Minitubers number/pl.	Diff./ Sign.	Minitubers number/pl.	Diff./ Sign.	
Azaria (b_1)	21.06	14.56 ***	45.89	40.00 ***	24.83 **
Brașovia (b_2)	29.69	23.19 ***	48.67	42.78 ***	18.98 *
Cosiana (b_3)	35.95	29.45 ***	48.61	42.72 ***	12.66 *
Cezarina (b_4) (Ct)	6.5	-	5.89	-	-0.61 ns

LSD (p 5%) = 7.30; (p 1%) = 10.25; (p 0.1%) = 14.48.

LSD (5%) = 11.36; (p 1%) = 21.79; (p 0.1%) = 57.16.

Table 15. Combined influence of cultivation period and variety on mean minitubers weight/plant (g) (NIRDPSB Brașov, 2025)

Cultivation period (a)/ Variety (b)	Winter-spring (a_1)		Summer-autumn (a_2)		a_2-a_1 (cm)/ Sign.
	Minitub. weight/ pl. (g)	Diff. (g)/Sign.	Minitub. weight/ pl. (g)	Diff. (g)/Sign.	
Azaria (b_1)	251.20	220.87 ***	410.11	362.09 ***	158.91 **
Brașovia (b_2)	380.49	350.16 ***	494.17	446.15 ***	113.68 *
Cosiana (b_3)	479.60	449.27 ***	476.14	428.12 ***	-3.46 ns
Cezarina (b_4) (Ct)	30.33	-	48.02	-	17.69 ns

LSD (p 5%) = 82.17 g; (p 1%) = 115.34 g; (p 0.1%) = 162.83 g.

LSD (5%) = 86.30 g; (p 1%) = 139.29 g; (p 0.1%) = 278.58 g.

The aeroponic method determined significant increases in minitubers weight/plant (494.17 g; 410.11 g) during the summer-autumn period compared to the winter-spring (380.49 g; 251.20) for Brașovia and Azaria varieties (Table 15).

For Azaria variety, mean weight increased from 251.20 g/plant in the winter-spring period to 410.11 g/plant in the summer-autumn period, the difference of 158.91 g/plant being distinctly significant ($p < 0.01$), exceeding the corresponding LSD values.

In the case of the Brașovia variety, the values were 380.49 g/plant in the winter-spring crop and 494.17 g/plant in the summer-autumn crop, with a difference of 113.68 g/plant, statistically significant at $p < 0.05$.

For Cosiana variety, the mean weight of minitubers/plant remained relatively constant between the two cultivation periods (479.60 g in the winter-spring period and 476.14 g in the summer-autumn period), the negative difference of 3.46 g being statistically insignificant, which indicates a high stability of this variety to the crop conditions.

The control variety Cezarina recorded low values of minituber weight/plant in both periods (30.33 g in winter-spring and 48.02 g in summer-autumn), with an insignificant difference.

The summer-autumn crop determined notable increases in the number of minitubers >15 mm for most varieties, compared to the winter-spring crop: Azaria: 45.89 versus 21.06 minitubers/plant, highlighting an increase of 24.83 minitubers/plant; Brașovia: 48.67 versus 29.69; Cosiana: 48.61 versus 35.95 (Table 16). Regarding the total number of minitubers, the summer–autumn crop determined an average increase from 50.39 to 53.84 minitubers/plant. The most productive varieties were Brașovia (69.50) and Azaria (72.17), followed by Cosiana (60.55).

Summer–autumn cultivation favored significant increases in weight of minitubers >15 mm for most varieties: for Azaria the weight of minitubers >15 mm increased from 251.20 g/plant in winter-spring to 410.11 g/plant in summer-autumn, with a difference of 158.91 g/plant, for Brașovia: from 380.49 g/plant to 494.17 g/plant, a difference of 113.68 g/plant, indicating a high capacity for mass accumulation in large tubers, for Cosiana: the weight of minitubers >15 mm remained relatively constant (from 479.60 g/plant to 476.14 g/plant), the difference being very small, suggesting high productive stability (Table 17).

These results show that the summer-autumn period favors mass accumulation in large minitubers, with a direct impact on the quality of the planting material.

Table 16. Number of minitubers obtained depending on variety and cultivation period

Cultivation period/ Variety	Winter-spring			Summer-autumn			Mean for the 2 cultivation periods		
	Minitubers number/pl.		Total number of minitubers /pl.	Minitubers number/pl.		Total number of minitubers /pl.	Minitubers number/pl.		Total number of minitubers /pl.
	<15mm	>15 mm		<15mm	>15 mm		<15mm	>15 mm	
Azaria	16.28	21.06	37.34	26.28	45.89	72.17	21.28	33.48	54.76
Brasovia	67.42	29.69	97.11	20.83	48.67	69.50	44.13	39.18	83.31
Cosiana	16.00	35.95	51.95	11.94	48.61	60.55	13.97	42.28	56.25
Cezarina	8.67	6.50	15.17	7.24	5.89	13.13	7.96	6.20	14.15
Mean	27.09	23.30	50.39	16.57	37.27	53.84	21.83	30.28	52.12

Figure 17. Minitubers weight obtained depending on variety and cultivation period

Cultivation period/ Variety	Winter-spring			Summer-autumn			Mean for the 2 cultivation periods		
	Mean weight (g) of minitubers/pl.		Total minitubers weight (g)/ pl.	Mean weight (g) of minitubers/pl.		Total minitubers weight (g)/ pl.	Mean weight (g) of minitubers/pl.		Total minitubers weight (g)/ pl.
	<15mm	>15 mm		<15mm	>15 mm		<15mm	>15 mm	
Azaria	27.24	251.20	278.44	44.83	410.11	454.94	36.04	330.66	366.69
Brasovia	103.45	380.49	483.94	70.34	494.17	564.51	86.90	437.33	524.23
Cosiana	21.69	479.60	501.29	28.36	476.14	504.50	25.03	477.87	502.90
Cezarina	17.85	30.33	48.18	14.45	48.02	62.47	16.15	39.18	55.33
Mean	42.56	285.41	327.96	39.50	357.11	396.61	41.03	321.26	362.28

Considering the small number of cultivars analysed in this study, future research will focus on a higher number of genotypes.

CONCLUSIONS

The results obtained 1 and 2 months after transfer demonstrated that variety is the primary factor influencing plant height and root system development, the genetic influence being highlighted by highly statistically significant differences ($p < 0.01$).

Among the varieties analyzed, Cosiana consistently stood out with the highest values of plant height and root length across both cultivation period, confirming its superior biological potential and excellent adaptability to the aeroponic method.

The cultivation period had a differentiated effect depending on analyzed parameter.

Thus, plant height was favored by the summer–autumn period, especially in the evaluation carried out 2 months after transfer, when a distinctly significant positive difference was recorded (24.13 cm).

In contrast, root length was not significantly influenced by the cultivation period.

Brașovia and Cosiana varieties showed high vegetative and root growth vigor.

Regarding minituberization capacity, the summer-autumn cultivation period significantly increased both the number and weight of minitubers per plant compared to the winter-spring period.

The variety also exerted a very significant influence on these parameters.

Cosiana and Brașovia varieties, in both cultivation periods, recorded the highest values of number and weight of minitubers, being classified in the higher groups of statistical significance, without significant differences between them.

The Cosiana variety stood out for its high production stability, achieving constant minituber weight values regardless of season, which recommends it for wide-scale use in aeroponic systems.

Cosiana and Brașovia varieties stand out as the most valuable from an agronomic point of view, having a high potential for use in minituber production programs under artificial conditions.

The aeroponic method proved effective for producing minitubers, and the choice of high-performing variety, correlated with the optimal cultivation period isessential to maximize biological and productive performance.

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REFERENCES

Broćić, Z., Milinković, M., Momčilović, I., Oljača, J., Veljković, B., Milošević, D., Poštić, D., 2019. *Comparison of aeroponics and conventional production system of virus-free potato mini tubers in Serbia*. Agro-knowledge Journal, 20(2): 95-105.

Broćić, Z., Momčilović, I., Poštić, D., Oljača, J., Veljković, B., 2021. *Production of High-Quality Seed Potato by Aeroponics*. In The Potato Crop: Management, Production, and Food Security, Villa, P.M., Ed., Nova Science Publishers: New York, NY, USA: 25-59.

Broćić, Z., Oljača, J., Pantelić, D., Rudić, J., Momčilović, I., 2022. *Potato Aeroponics: Effects of Cultivar and Plant Origin on Minituber Production*. Horticulturae 2022, 8, 915.

Čížek, M., and Komárková, Z., 2022. *Comparison of aeroponics technology with a conventional system of production of potato minitubers in the conditions of the Czech Republic*, Plant, Soil and Environment, 68, 2022 (8): 366-374.

Hartinger, S.C., de Matos, C.K., Moccellin, R., Faria, C.M.D.R., Kawakami, J., 2025. *Plant Growth-Promoting Microorganisms: Performance of Potato Cultivars in Aeroponics*. Potato Res., 68: 1965-1984. https://doi.org/10.1007/s11540-024-09813-1

Ngawang, P.W., and Dochen, T., 2013. *Aeroponics: defying conventions*. Annual RNR Magazine, 3(1).

Ngawang, P.W., and Dochen, T., 2014. *Aeroponic production of potato minitubers*. National Potato Program Department of Agriculture.

Rykaczewska, K., 2016. *The potato minituber production from microtubers in aeroponic culture*. Plant Soil Environ., 62(5): 210-214.

Sinha, A., Solankey, S.S., Akhtar, S., Patel, P., 2025. *Advances in Potato Mini-tubers Production through Aeroponics and ARC Techniques*. In: Solankey, S.S. (eds.), Advances in Research on Potato Production, Advances in Olericulture, Springer, Cham. https://doi.org/10.1007/978-3-031-82710-5_7

Tican, A., 2018. *Experimenting hydroponic culture systems on different substrates to obtain potato minitubers*. Rom. Agric. Res., 35: 147-153. https://doi.org/10.59665/rar3519

Tican, A., Chiru, N., Cioloca, M., Bădărău, C.L., 2018a. *Obtaining minitubers by applying hydroponic culture*. Rom. Agric. Res., 35: 141-146. https://doi.org/10.59665/rar3518

Tican, A., Cioloca, M., Ștefan, M., Bădărău, C.L., 2018b. *Previous results on obtaining minitubers by aeroponic method applied at National Institute of Research and Development for Potato and Sugar Beet Brasov*. Journal of Horticulture, Forestry and Biotechnology, 22(4): 136-139.

Tican, A., Cioloca, M., Popa, M., 2025. *Study reffering to potato mini tubers production using various culture systems*. Rom. Agric. Res., 42: 133-139. https://doi.org/10.59665/rar4211

Wasilewska-Nascimento, B., Boguszewska-Mańkowska, D., Zarzyńska, K., 2020. *Challenges in the Production of High-Quality Seed Potatoes (Solanum tuberosum L.) in the Tropics and Subtropics*. Agronomy, 10, 260. https://doi.org/10.3390/agronomy10020260