Scientific Papers. Series A. Agronomy, Vol. LXVIII, No. 2, 2025
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

STUDY ON OBTAINING POTATO MINITUBERS BY USING VARIOUS CULTURE SUBSTRATE

Andreea TICAN, Mihaela CIOLOCA, Monica POPA

National Institute of Research and Development for Potato and Sugar Beet Braşov,
2 Fundăturii Street, 500470, Braşov, Romania

Corresponding author email: tican_andreea@yahoo.com

Abstract

The modernization of the production of planting material for potato cultivation and especially the production of minitubers on industrial substrate represents a highly topical research direction worldwide, in line with the major objective of upgrading potato cultivation in Romania. The Research Laboratory for Plant Tissue Cultures, of the National Institute of Research and Development for Potatoes and Sugar Beet Braşov evaluated the minituberization process was on two culture substrates for four genotypes to observe whether the use of industrial substrate is more efficient than soil. The biological material used consisted of virus-free in vitro plants, starting from the culture of meristems. In vitro potato plants were planted on the two types of substrates. Determinations of number and weight of the minitubers were made. The industrial substrate favoured the production of a higher average number of minitubers (7.82 minitubers) with a distinctly significant positive difference, compared to the conventional substrate (6.94); also on industrial substrate the average weight of minitubers was higher than on peat

Key words*: potato, in vitro plants, variety, culture substrate, minitubers.*

INTRODUCTION

Food security has become a crucial issue due to climate change, reducing arable land areas, population growth and the frequent occurrence of natural disasters. To deal with this situation, increasing the food supply has become a priority.

The soilless cultivation technique facilitates many socio-economic benefits, including the ability to address growing global food challenges, environmental changes aimed at alleviating malnutrition, and the efficient management and use of natural resources.

The potato is a versatile and affordable staple food that plays a significant role in global food security, and its mild flavour and diverse culinary applications make it popular worldwide.

The development of new technology for food production is used to sustain the transformation of agriculture in response to population growth and resource demands (Gebreegziher, 2023). One emerging and promising technique to overcome current threats facing in soil-based dryland vegetable farming is soilless culture.

In the global horticultural production, vegetable crops 'without soil' had begun already gain a leading position. These unconventional systems of culture are great interest both for researchers and for those who practice in order to achieve products for human consumption.

Expanded perlite is a substrate of culture that completely replaces soil (Drăghici et al., 2013). Perlite which is less expensive than rockwool has been used as soilless culture substrate around the world for successful production of vegetables, in the greenhouse (Jerca, 2015). Perlite is a sterile medium free of bush and pathogens and excellent medium for germination (Alkhateeb et al., 2019). Perlite is a material resulting from heating silicon volcanic rocks from 900 to 1000 degrees Celsius (Faleh, 2023). This heating results in countless air gaps that absorb water by 430% of their volume. Perlite has a moderate pH and is light in weight. It is used as a carrier for fertilizers, herbicides, and pesticides (Faleh, 2023). Perlite is widely preferred as it encourages faster root development, reduces risk of damping off, avoids water logging and provides an optimum balance of air and water (Asaduzzaman, 2013). In general, it has a closed cellular structure, with the majority of water being retained superficially and released slowly at a relatively low tension, providing

excellent drainage of the medium and aeration of rhizosphere (Markoska et al., 2018).
Artificial growing system provides plants with mechanical support, water and mineral nutrient for higher growth and development (Asaduzzaman et al., 2015).
Substrates are formulated from various inorganic and organic components to provide suitable physical and chemical properties as required by the specific crop and growing conditions (Markoska et al., 2018).
Use of media type possibly is the most intensive culture system utilizing all the resources efficiently for maximizing yield of crops and the most intense form of agricultural enterprises for commercial production of greenhouse crops (Makau et al., 2021). They are considered as important technologies for better water use efficiency as well as high good quality and quantity products. Number of organic and inorganic materials such as gravel, sand, peat, sawdust, pumice, tuff, coir, vermiculite, perlite, and rock wool pure or in mixture are used as solid growing media in addition to hydroponics (Makau et al., 2021).
In the conditions of our country, in recent years there has been an interest increase of unconventional culture technologies, which open attractive perspectives for professional growers (Atanasiu, 2007).
In Romania, concerns regarding the use of soilless methods are materializing especially in the research sector, with no trends for their implementation at national level for now.
At National Institute of Research and Development for Potato and Sugar Beet Brasov, within the Research Laboratory for Plant Tissue Cultures, various studies were conducted on the behaviour of potato varieties created by the specialized staff of the Research Laboratory for Genetic Breeding and Plant Selection.
Well-trained personnel are needed to carefully monitor fertigation and the main factors: the pH of the nutrient solution and the electroconductivity value, which for potatoes is not recommended to exceed 2 ms/S.
The minituberization process was evaluated on different hydroponic systems with and without automation and on different culture substrates: perlite, clay (Tican, 2018; Tican et al., 2025). In 2016, the Castrum variety recorded higher values for the number of minitubers/plant (11.0), followed by the Marvis variety (10.20 minitubers/plant) (Tican et al., 2018).

MATERIALS AND METHODS

In the year 2024, within the Research Laboratory for Plant Tissue Cultures, of the National Institute of Research and Development for Potatoes and Sugar Beet Brasov, the minituberization process was evaluated on different culture substrates, in a bifactorial experience, of the 2*4 type, in which factor a was the culture substrate: with two gradations: a_1 – perlite industrial substrate; a_2 – conventional substrate consisting of a mixture of peat and perlite, and factor b: the variety, with four gradations: Azaria, Brasovia, Cosiana and Cezarina. The statistical analysis was performed by the ANOVA program.
The biological material used consisted of virus-free *in vitro* plants, starting from the culture of meristems.

Figure 1. *In vitro* potato plants

At the beginning of May 2024, *in vitro* plants (Figure 1) were transferred to an “insect proof” protected area and planted on the two types of substrates, to obtain minitubers (these are being the first link in the national seed potato production system).
Figure 2 shows aspects of the development of potato plants on perlite substrate. For the plants that were grown on the substrate with perlite, a nutrient solution (prepared in the laboratory) was administered, based on: nitrogen, phosphorus, potassium, magnesium, iron, manganese, copper, zinc, boron, molybdenum, and the electroconductivity was 2 mS/cm. In October minitubers (Figure 3) were harvested and determinations of the number and weight of the minitubers obtained were made.

At the beginning of May 2024, *in vitro* plants (Figure 1) were transferred to an "insect proof" protected area and planted on the two types of substrates, to obtain minitubers (these are being the first link in the national seed potato production system).

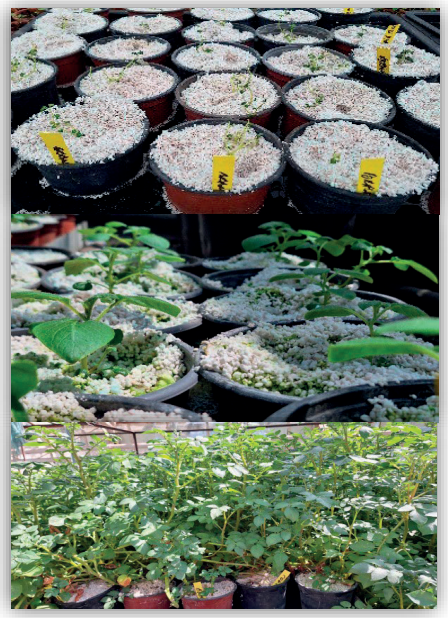

Figure 2. Plant development on industrial substrate

Figure 2 shows aspects of the development of potato plants on perlite substrate. For the plants that were grown on the substrate with perlite, a nutrient solution (prepared in the laboratory) was administered, based on: nitrogen, phosphorus, potassium, magnesium, iron, manganese, copper, zinc, boron, molybdenum, and the electroconductivity was 2 mS/cm. In October minitubers (Figure 3) were harvested and determinations of the number and weight of the minitubers obtained were made.

The production of potato minitubers is the classic intermediate step and represents connections between the biological material obtained *in vitro* and tubers produced in the clonal field. The techniques used for the production of minitubers are diverse, but they are mainly based on the propagation of microplants on a classic substrate or on an industrial substrate.

Figure 3. Minitubers obtained on industrial substrate

The scheme for producing minitubers starting from the meristem is shown in Figure 4.

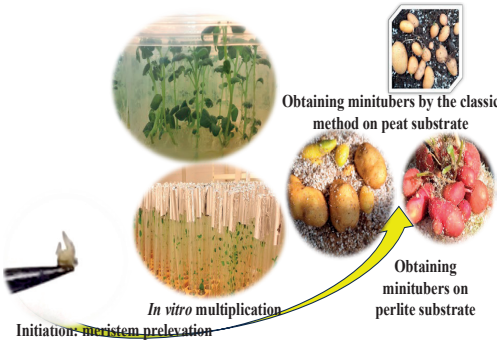

Figure 4. the steps for obtaining minitubers (potato pre-base material) starting from the virus-free meristematic explant

RESULTS AND DISCUSSIONS

Table 1 shows the significant influence of the culture substrate, the variety on number of minitubers obtained. The cultivar studied and the culture substrate interaction with cultivar had a significant influence on the weight of minitubers.

Table 1. Analysis of variance

Analysis of variance for minitubers number/plant				
Source of variation	Sum of squares	DF	The mean square	F
Culture substrate (a)	4.65521	1	4.65521	107.718 **(18.51; 98.50)
Variety (b)	104.99610	3	34.99868	11.616 **(3.49; 5.95)
Culture substrate*Variety	27.74687	3	9.24896	3.070 ns (3.49; 5.95)
Analysis of variance for minituber weight/plant				
Culture substrate (a)	2833.15800	1	2833.15800	4.221 ns (18.51; 98.50)
Variety (b)	22125.38000	3	7375.12700	5.359 *(3.49; 5.95).
Culture substrate*Variety	24996.15000	3	8332.05200	6.054 **(3.49; 5.95)

df, degrees of freedom.
*Significant at the 0.05 probability level.
**Significant at the 0.01 probability level.
ns - not significant

From the analysis of the influence of the culture substrate on the number of minitubers, a distinctly significant positive difference can be observed when using the perlite industrial substrate. Regarding the weight of the minitubers obtained, the difference is not significant, but positive when using the perlite substrate, compared to the conventional substrate (Table 2).

Table 2. The culture substrate influence on minitubers number of and their weight (g)/plant

Culture substrate (a)	Minitubers number	Diff./ Sign.	Minitubers weight (g)	Diff. (g)/Sign.
Industrial substrate (a_1)	7.82 A	0.88 **	127.75 A	21.73 ns
Peat-perlite (a_2) (Ct)	6.94 B	-	106.02 A	-

LSD 5% = 0.36; LSD 5% = 45.48;
1% = 0.84; 1% = 105.03;
0.1% = 2.68 0.1% = 334.23

Means found in the same columns followed by the same letters are not significant according to the Duncan test ($p \leq 0.05$).

The analysis of variety influence highlights for the first element analyzed (Table 3), number of minitubers, the superiority of Cezarina variety, which registers the highest number of minitubers (9.31), followed by the Azaria and Brașovia varieties (9.03 and 7.11 minitubers), without to differ significantly (according to Duncan test). By studying variety influence on mean weight of the minitubers/plant, it is observed that the varieties Azaria and Brașovia determined the achievement of statistically assured results, with distinctly significant positive differences (77.67 and 68.66 g), compared to the control variety (Cezarina).

Table 3. The variety influence on minitubers number of and their weight (g)/plant

Variety (b)	Minitubers number	Diff./ Sign.	Minitubers weight (g)	Diff. (g)/Sig.
Azaria (b_1)	9.03 A	-0.27 ns	148.33 A	77.67 **
Brașovia (b_2)	7.11 A	-2.20 o	139.32 A	68.66 **
Cosiana (b_3)	4.07 B	-5.24 ooo	109.21 AB	38.55 ns
Cezarina (b_4) (Ct)	9.31 A	-	70.66 B	-

LSD 5% = 2.18; LSD 5% = 46.69;
1% = 3.07; 1% = 65.54;
0.1% = 4.33 0.1% = 92.53

Means found in the same columns followed by the same letters are not significant according to the Duncan test ($p \leq 0.05$).

For Cosiana variety, the industrial substrate had a negative influence, leading to the lowest number of minitubers (2.80), with a very significant negative difference compared to the control variety. The best behaviour of the cultivars regarding minitubers formation was presented by Azaria and Cezarina cultivars, which obtained a high number of minitubers (10.07 and 9.70), without significant differences. On mixture peat-perlite substrate, Cezarina variety obtains the highest number of minitubers (8.92), but this number is inferior to the same variety on the industrial substrate (9.70), degerming a positive difference, but insignificant between the two types of substrates, for the control variety (0.78 g). For the Brașovia variety, there is a significant difference (3.21 minitubers), positive, between industrial substrate and conventional substrate (Table 4).

Table 4. Combined influence of culture substrate and cultivar on mean number of minitubers/plant

Culture system/ Variety	Industrial substrate (a_1)		Peat-perlite (a_2)		a_1-a_2 Sign.	
	Minitub. number	Diff. Sign.	Minitub. number	Diff. Sign.		
Azaria	10.07	0.37 ns	8.0	-0.92 ns	2.07	ns
Brașovia	8.81	-0.99 ns	5.50	-3.42 o	3.21	*
Cosiana	2.80	-6.90 ooo	5.33	-3.58 o	-2.53	ns
Cezarina (Ct)	9.70	-	8.92	-	0.78	ns

LSD 5% = 3.09; LSD 5%= 2.69;
1% = 4,34; 1% = 3.80;
0,1% = 6.12. 0.1% = 5.74

On industrial substrate, the superior capacity of Azaria and Brașovia varieties is observed (Table 5) to form minitubers with a higher mean weight/plant, compared to the control variety, and significant positive differences

(78.82 and 71.04 g). On conventional substrate, Cosiana variety obtains a distinctly significant positive difference (111.88 g), compared to the Cezarina variety. When analysing the mean weight of minitubers obtained, between the two types of substrates, for Cezarina variety, a significant negative difference was obtained (90.03); the other varieties obtained positive, but insignificant differences on the industrial substrate compared to the classical substrate.

Table 5. Combined influence of culture substrate and cultivar on mean weight of minitubers (g)/plant

Culture system/ Variety	Industrial substrate (a_1)		Peat-perlite (a_2)		a_1-a_2 Sign.	
	Minitub. weight (g)	Diff. (g) Sign.	Minitub. weight (g)	Diff. (g) Sign.		
Azaria	177.79	78.82 *	118.87	76.52 *	58.93	ns
Brașovia	140.02	71.04 *	108.63	66.28 *	61.39	ns
Cosiana	64.20	-34.78 ns	154.23	111.88 **	-90.03	o
Cezarina (Ct)	98.98	-	42.35	-	56.63	ns

LSD 5% = 66.03; 1% = 92,69; 0,1% = 130.85.

LSD 5%= 70.04; 1% = 113.72; 0,1% = 230.09.

CONCLUSIONS

The industrial substrate favoured production of a higher mean number of minitubers (7.82 minitubers), compared to the conventional substrate (6.94 minitubers). Varieties Cezarina, Azaria and Brasovia recorded higher values of minitubers number (9.31; 9.03; 7.11), significantly different from the variety Cosiana (4.07). Variety Cezarina, although it had the ability to form a large number of minitubers, their weight was low.

Azaria and Cezarina varieties showed the best behaviour regarding minitubers formation on industrial substrate, which obtained a high number of minitubers (10.07 and 9.70), without significant differences.

On the peat-perlite substrate, Cezarina variety obtained the highest number of minitubers (8.92), but this number is inferior to the industrial substrate (9.70).

For Brașovia variety, there is a significant difference (3.21 minitubers), positive, between the industrial substrate and control substrate.

On industrial substrate, the superior capacity of Azaria and Brașovia varieties to form minitubers with high average weight/plant (177.79 and 140.02 g) can be observed.

ACKNOWLEGMENTS

This research work was carried out with the support of National Institute of Research and Development for Potato and Sugar Beet Brasov and also was financed from PN 23 19 01 01 Project "Research on increasing the performance process of the potato minitubers production using an intelligent aeroponic system", period 2023-2026, and represents a part of researches from this project and from PN 23 19 01 02 "Research on the resistance and tolerance of some Romanian potato varieties to the main viruses with high harmful potential under climate change conditions".

REFERENCES

Alkhateeb, B. A. A. H., Alshamary, W. F. A. and Aljumily, A. M. H. (2019). The role of perlite and irrigation management in water consumptive, growth and yield of potato *Solanum Tuberosum* L. in sandy loam soil. *Biochem. Cell. Arch*. Vol. 19, No. 2, pp. 4063-4072, DOI: 10.35124/bca.2019.19.2.4063.

Asaduzzaman, Md., Kobayashi, Y., Fuad, M. Md., Ban, T., Matsubara, H, Adachi, F., Asao, T. (2013). Growing carrots hydroponically using perlite substrates. *Scientia Horticulturae, Volume 159*, pp. 113-121, ISSN 0304-4238, https://doi.org/10.1016/j.scienta.2013.04.038.

Asaduzzaman, Md., Saifullah, Md., Mollick K. M. S. R., Hossain, Md. M., Halim, G. M. A. and Asao T. (2015*). Influence of Soilless Culture Substrate on Improvementof Yield and Produce Quality of Horticultural Crops*, Chapter 1, Publisher: InTech http://dx.doi.org/10.5772/59708.

Atanasiu, N. E. (2007). *Agricultural crops without soil*, 2nd edition revised and added, ATAR Publishing House, Bucharest.

Drăghici, E. M., Pele, M., Dobrin, E. (2013). Research concerning effects of perlite substrate on tomato in soilless culture. *Scientific Papers. Series B, Horticulture. Vol. LVII*, pp. 45-48 Print ISSN 2285-5653.

Faleh, S. T., Abood, M. A. and Fahmi A. H. (2023). The Role of Biochar and Perlite in Improving some Physical Properties of Clay Loam and Sandy Loam Soil, *IOP Conf. Series: Earth and Environmental Science*, IOP Publishing doi:10.1088/1755-1315/1259/1/012020.

Gebreegziher, W. G. (2023). Soilless culture technology to transform vegetable farming, reduce land pressure and degradation in drylands. *Cogent Food & Agriculture*, 9(2). https://doi.org/10.1080/23311932.2023.2265106.

Jerca, I. O., Cîmpeanu, S. M., Dudu, G., Burghilă, D. V. (2015). Study on the influence of the type of substrate and the quantity upon the tomato crop. *Scientific*

Papers. Series B, Horticulture. Vol. LIX, pp. 225-228, Print ISSN 2285-5653.

Makau, M. F., Mwangi, M., Oyoo, M. E, Kibe, A. M. (2021). Effect of media type on growth of potato (*Solanum tuberosum* L.) varieties apical rooted cuttings in Kenya. *European Journal of Science, Innovation and Technology, 3*(3), 233-240.

Markoska, V., Spalevic, V., Lisichkov, K., Atkovska, K. and Gulaboski, R. (2018). Determination of water retention characteristics of perlite and peat. *Agriculture & Forestry, Vol. 64 Issue* 3: 113-126, 2018, Podgorica.

Tican, A. (2018). Experimenting hydroponic culture systems on different substrates to obtain potato minitubers. *Romanian Agricultural Research*, no. 35, pp. 141-146.

Tican, A., Chiru, N., Cioloca, M., Badarau, C.L. (2018). Obtaining minitubers by applying hydroponic culture. *Romanian Agricultural Research*, no. 35, pp. 147-153.

Tican, A., Cioloca, M., Popa, M. (2025). Study reffering to potato mini tubers production using various culture systems. *Romanian Agricultural Research*, no. 42, pp. 133-139.