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OBTAINING MINITUBERS BY APPLYING METHOD OF CULTURE ON SUBSTRATES INDUSTRIAL

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Abstract

National Institute of Research and Development for Potato and Sugar Beet Brasov in 2016 INCDCSZ investigated two hydroponic systems to see the behavior of different potato Romanian varieties (Braşovia, Castrum, Marvis and Sarmis) regarding the following parameters: the number of minitubers/plant and weight of minitubers/plant. As hydroponic systems it was used one with circulating nutrient solution and another one with static layer of nutrient solution and for both cases the substrate used was perlite. Regarding the average weight of minitubers/plant, the plants culture on circulating nutrient solution had a beneficial influence comparative with culture on static stratum of nutrient solution, which recorded a highly significant difference in minituber weight compared to the first mentioned, statistically assured. Analyzing the number of minitubers using the hydroponic culture, relative to control variety (Brasovia with 5.10 minitub./pl.) shows that the Castrum variety gets the best results with a positive significant distinct difference (+5.90 minitub./pl.) followed by variety Marvis with a positive significant difference (+5.10 minitub./pl.). Varieties influence on weight mintub./pl. shows that the difference is very significant positive for Marvis variety (+42.49 g), compared to control variety and insignificant for the other varieties. From the obtained data we recommend using hydroponic system with nutrient solution circulating.

Key words: *hydroponics, minitubers, nutrient solution, perlite, plantlets.*

INTRODUCTION

The world's population increased greatly in last few decades. The improvement of living standard in many countries increased with the great demand for high value crops, off season supply and high quality products. Therefore, quality of life of people increased considerably. In this regard, protected agriculture which is a labor intensive industry can produce higher amount of food for the increased population of the world. The efficiency and quality of the agricultural produce can be increased through the modifications of the environmental controls, management of culture systems and use of technological innovations. The greatest advantage of soilless culture is that it allows direct control of the nutrient solution, possible to modify composition and concentration to achieve predictable results in relation to dry matter content, nitrate content or other organoleptic and structural features of the crop produce (Elia A. and colab. 1999 cited by, Asaduzzaman and colab. 2015). The soil is usually most available growth medium for plants. For a successful plant growth, soil provides nutrients, air, water, etc. Changing the soil with another alternative growth medium tends to be expensive.

Sometimes, the soil may create limitations on the growth of plants. Some of these are: the presence of disease-causing organisms and pests, inadequate soil reaction, unfavorable soil compaction, poor drainage, degradation due to erosion, etc. (Hussain et al., 2014).

Hydroponic method application has increased significantly in recent years, worldwide, because it allows a more efficient use of water and fertilizer, and better control of climate and nuisance factors (Trejo-Téllez and Gómez-Merino, 2012).

By using the hydroponic method increases crop quality and productivity, leading to increased competitiveness and economic income (Trejo-Téllez and Merino Gómez-2012). Using hydroponic systems offers an excellent alternative by reducing the potential risk of roots contamination with pathogens and tubers from the soil and eliminating chemical disinfectants, which are generally very harmful to human health and the environment (Scherwinski-Pereira et al., 2009).

Horticultural crops "without soil" is now a true peak of high-performance technologies that have already gained a leading position in world agriculture crop production (Atanasiu, 2007). In conditions of our country, in recent years there has been increased interest in these unconventional technologies culture that open attractive prospects for professional growers (Atanasiu, 2007).
Advantages of hydroponic culture: cultures can be grown where there is no suitable soil or where the soil is contaminated with pathogens; watering and other traditional practices are largely eliminated; possible maximum yields, which makes the system without soil to be economically feasible in high density; conservation of water and nutrients is a feature for all systems; this will reduce pollution; a more complete environmental control is a general feature of the system.

MATERIALS AND METHOD

The study was done in 2016 in Laboratory of Vegetal Tissue Culture, National Institute of Research and Development for Potato and Sugar Beet Brasov.
The biological material used in the study consisted in: meristems for obtain a material free of virus. After 6-8 months biological material, by *in vitro* subculture, was represented by plantlets, from Braşovia, Castrum, Marvis and Sarmis varieties.
Potato seed starts from a virus-free meristem located in the apex growth (meristem dimensions are 0.1-0.2 mm). Meristematic explants are inoculated in test tubes containing Murashige-Skoog (1962) medium.
After a period of 6-8 months, depending of genotypes, from meristems are developed vitroplants (plantlets) (fig. 1).
To ensure the phytosanitary accuracy DAS ELISA test is performed.
The infected plantlets are eliminated and we multiplied *in vitro* only the healthy ones. *In vitro* multiplication is performed in sterile conditions, by segmenting at every internode and minicuttings obtained are inoculated on fresh Murashige-Skoog medium for the formation of new plantlets.
After obtaining a sufficient number of plantlets, these plants are planted in hydroponic system (fig. 2) with circulating nutrient solution (a) and static stratum of nutrient solution (b) in protected space "insect-proof".
The experience was bifactorial, 4x2 and number of repetitions was 5: experimental factor A, type of culture in hydroponic system with 2 graduations: a_1- culture on circulating nutrient solution; a_2 - culture on static layer of nutrient solution; experimental factor B, cultivar with 4 graduate: b_1- Braşovia; b_2- Castrum; b_3- Marvis; b_4 – Sarmis.

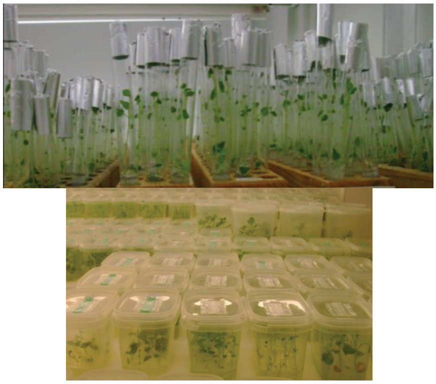


Figure 1. Plantlets

a

b

Figure 2. Planting *in vitro* material in hydroponic culture: with circulating nutrient solution (a) and static stratum of nutrient solution (b)

Other materials used in experience: a recirculating hydroponic system which can reuse unabsorbed nutrient solution during the process of irrigation, containing: basin, tray, pots, pump, supply system; culture tanks (trays) for pots with industrial substrate made of galvanized sheet with sides 0.9 m and height of 10cm ferry with a stopper drain and refresh with new solution; perlite used as substrate for plant rooting; fertilizers: nutrient solutions for culture without soil „Universol".

In the first stage our aim was to have a higher concentration of nitrogen, then in the second stage to have a higher concentration of phosphorus and potassium, respecting levels specified in the technical prospectus in accordance with the needs of plants in N, P_2O_5, K_2O, MgO, and micro elements, namely: Yellow Universol 12 + 30 + 12 + 2 MgO + micro elements (at a concentration of 0.5 to 1.0 g/l); Violet Universol 9 + 9 + 27 + 9 MgO + micro elements (at a concentration of 0.5 to 1.5 g/l).

Phases of potato seed production program by using hydroponic culture method are:

In the first year: tubers of the best clones of varieties are selected; the tubers are washed and kept in laboratory conditions, to light for sprouting; in February-March meristems are taken from tubers shoots and placed on the growth medium in tubes; subcultivation of meristems; in August and September from meristems are formed plantlets by multiplying stem cuttings; meristematic plantlets are tested; healthy cuttings are multipling further (and kept in tubes).

In the second year: multiplication of plants from January to April; transferring of plantlets in "insect-proof" space is performed in May, on industrial substrates; the growth medium is treated with preventive insecticide, as a precaution against aphids; is perform regular control of system to ensure accurate phytosanitary of plants is achieved ELISA; in the beginning of August the drip system is interrupted to stop the growth of plants; in late August - beginning of September is harvested minitubers; minitubers are located in the storage space (at a low temperature: 4^0C), the net bag;

The third year: minitubers are planted in isolated field (clonal field).

Haulms were cut two weeks before harvesting, then was performed harvesting, counting, and determining the average weight of minitubers/plant.

RESULTS AND DISCUSSIONS

Using method of analysis of variance, results obtained for variants planted in two variants of hydroponic system (Table 1) were interpreted statistically. For the first parameter, the average number of minitubers, the analyzed values were similar, the difference was not significant, statistically assured (-2.90 for minitubers obtained in system with static stratum of nutrient solution).

Table 1. Influence of hydroponic system used on the minitubers number obtained

Hydroponic system	The average number of minitubers produced/plant		Differences	Significance
	Number	%		
System with circulating nutrient solution (Ct)	9.80	100.00	-	-
System with static stratum of nutrient solution	6.90	70.40	-2.90	ns

DL 5%= 2.96; DL 1%= 4.96; DL 0.1%= 9.17

Table 2. Influence of hydroponic system used on the weight of minitubers obtained/plant

Hydroponic system	The average weight of minitubers produced/plant		Differences	Significance
	g	%		
System with circulating nutrient solution (Ct)	57.91	100.00	-	-
System with static stratum of nutrient solution	26.39	45.58	-31.52	ooo

DL 5%= 7.05 g; DL1%= 11.67g; DL 0.1%= 21.84 g

For the two types of systems in which minitubers were produced (Table 2), the difference in system with static stratum of nutrient solution reached -31.52 minitubers/plant, compared to the circulating solution, which is very significant negative, statistically assured.

For obtain minituber with high weight/plant it is recommended the system with circulating nutrient solution.
Regarding of the influence of variety (Table 3), by comparison with the control variety Brasovia is noted that Castrum variety had a distinct significant difference, positive by +5.90 minitub./plant and Marvis variety had a significant differences positive +5.10 minitubers/plant.
About the weight of minitub./plant (Table 4), statistical interpretation presents a very significant positive difference, statistically assured for Marvis variety (42.49 g).
In case of combined influence of hydroponic system and varieties studied (Table 5), a significant difference positive for number of minitubers, statistically assured was obtained for Marvis variety (+7.4 minitub/pl.) in case of culture with circulating nutrient solution. In hydroponic system with static stratum of nutrient solution Castrum variety recorded a significant difference positive (+7.2 minitub./pl.). Between the two hydroponic system models Marvis variety recorded a very significant negative difference in case of nutrient solution with static stratum (-7.20 minitub./pl). It can be seen that the values are higher for system with circulating nutrient solution, only Castrum variety presented the same number of minitubers in both cultures.

Table 3. The influence of variety on the average number of minituber obtained in hydroponic system

Variety	Number of minitubers/plant		Differences	Significance
	Number	%		
Brasovia (Ct)	5.10	100.00	-	-
Castrum	11.00	215.69	+5.90	**
Marvis	10.20	200.00	+5.10	*
Sarmis	7.10	139.22	+2.00	ns

DL 5% = 3.87; DL1% = 5.26; DL 0.1% = 7.04

Table 4. The influence of variety average weight of minitubers/plant in hydroponic system

Variety	The average weight of minitubers produced/plant)		Differences	Significance
	g	%		
Brasovia (Ct)	31.54	100.00	-	-
Castrum	28.57	90.58	-2.97	ns
Marvis	74.03	234.71	+42.49	***
Sarmis	34.46	109.27	+2.92	ns

DL 5% = 16.75; DL1% = 22.77 ; DL 0.1% = 30.51

Table 5. Influence of variety and hydroponic system on the average number of minituber obtained/plant

Hydroponic system / Variety	System with circulating nutrient solution, a1			System with static stratum of nutrient solution, a2			Dif.
	Number of minitub/plant	Dif	Sig	Number of minitub/plant	Dif.	Sig	a2-a1
Brasovia b_1	6.40	-	-	3.80	-	-	-2.60 *
Castrum b_2	11.00	+4.6	ns	11.00	+7.2	*	0.00 ns
Marvis b_3	13.80	+7.4	*	6.60	+2.8	ns	-7.20 ooo
Sarmis b_4	8.00	+1.6	ns	6.20	+2.4	ns	-1.80 ns

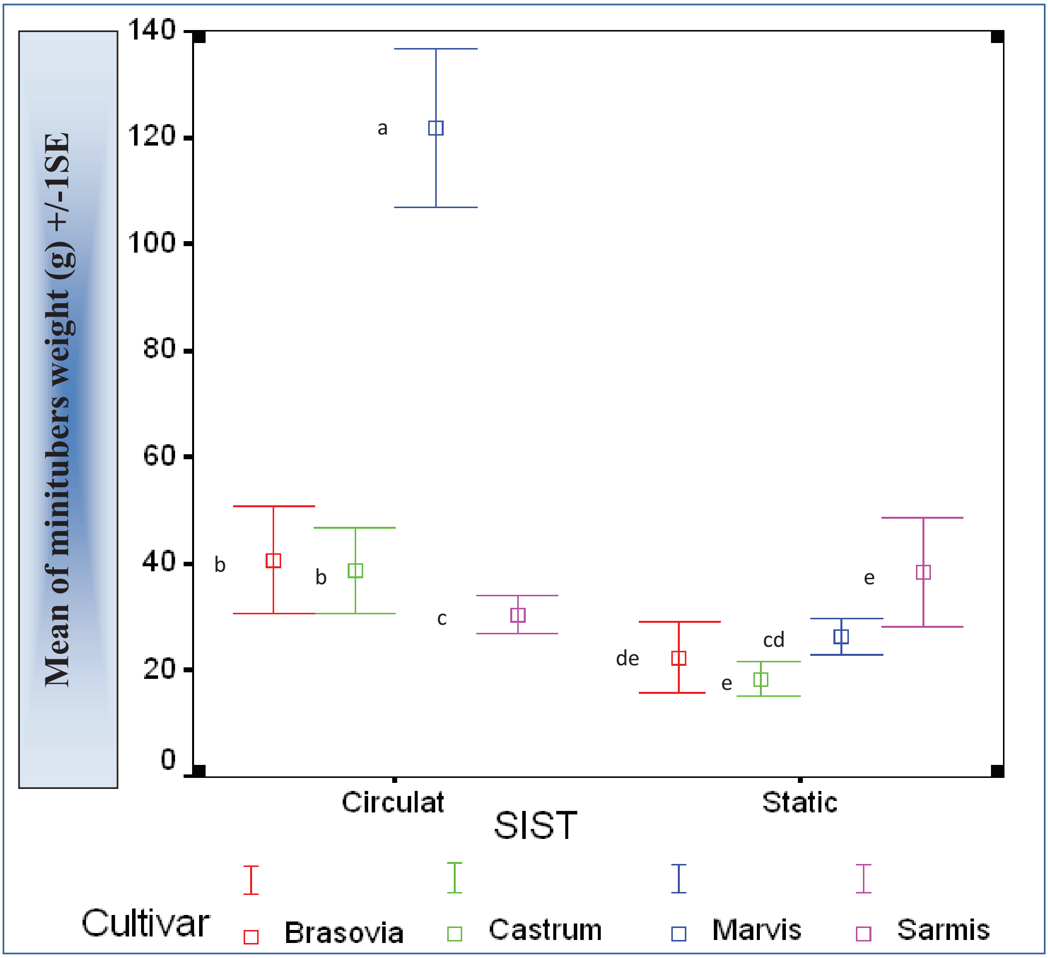
DL 5% =5.47 (minitub.) DL 5% =2.18 (minitub.)
DL 1%= 7.44 (minitub.) DL 1%=3,12 (minitub.)
DL 0,1%=9.96 (minitub.) DL 0,1%=4,61 (minitub.)

Statistical analysis on the influence on weight minitubers obtained (Table 6) shows that Marvis variety has a very significant positive difference of + 80.9 g. Comparing the two systems, only Sarmis variety obtain minitubers with a higher weight/pl., recording a significant positive difference (+7.92) in case of culture on static stratum; for the other varieties, the differences are very significant negative, this aspect showing us the beneficial influence of system with circulating nutrient solution regarding the weight of minitubers.

Table 6. Influence of variety and hydroponic system on the average weight of minituber/plant (g)

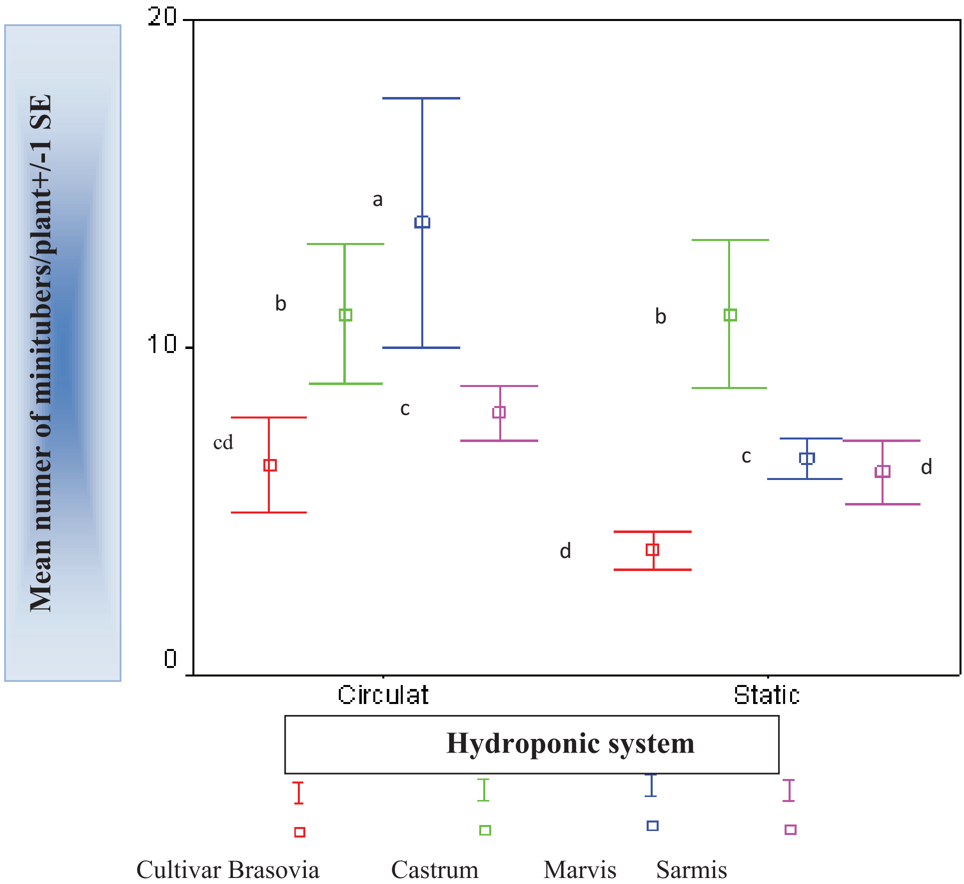
Hydroponic system / Variety	System with circulating nutrient solution, a1			System with static stratum of nutrient solution, a2			Dif.
	Average weight of minitur (g)	Dif.	Sig	Average weight of minituber (g)	Dif.	Sig	a2-a1
Brasovia b_1	40.70	-	-	22.38	-	-	-18.32 ooo
Castrum b_2	38.81	-1.89	ns	18.31	-4.07	ns	-20.5 ooo
Marvis b_3	121.60	+80.9	***	26.44	+4.06	ns	-95.16 ooo
Sarmis b_4	30.50	-10.2	ns	38.42	+16.04	ns	+7.92 *

DL 5% =23.70 (g) DL 5% =6.55 (g)
DL 1%= 32.21 (g) DL 1%=9.26 (g)
DL 0,1%=43.14 (g) DL 0,1%=12.87 (g)



The letters indicate differences between variants according of the ANOVA and Duncan test (P <0.05)

Figure 3. Hydroponically number of minitubers/variety was higher in system with circulating nutrient solution than in static stratum



The letters indicate differences between variants according of the ANOVA and Duncan test (P <0.05)
Figure 4. Hydroponically weight of minitubers/variety was higher in system with circulating nutrient solution than in static stratum

CONCLUSIONS

In conclusion, results of the presented study show that system with circulating nutrient solution can be a suitable system of producing potato pre-basic seed and it optimization may be considered as a strategic investment with the aim of promoting a more efficient and sustainable production of high quality potato minitubers.

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