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OBTAINING MINITUBERS BY APPLYING HYDROPONIC CULTURE

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ABSTRACT

Hydroponics growing method has proven to be a very successful strategy for the production of pre-base seed potatoes. NIRDPSB Brasov applied this method in 2016, by using two types of culture: with circulating nutrient solution and with static layer of nutrient solution and for both cases the substrate used was perlite. As biological material plantlets of four cultivars (Braşovia, Castrum, Marvis and Sarmis) were used and grown hydroponically in a space "insect-proof" under controlled conditions. The number of minitubers/plant and weight of minitubers/plant were compared for the used cultivars. By using circulating nutrient solution in hydroponic system, Marvis variety (13.80 minitubers/plant) and Castrum variety (11 minitubers/plant) were the best performing of the four cultivars. The hydroponic system with circulating nutrient solution had a positive impact on the mean weight of minitubers/plant, with Marvis variety, recording the highest value (121.6 g).

Key words: **nutritive** solution, substrate, hydroponics, plantlets, minitubers, potato.

INTRODUCTION

In European countries, minitubers production technology has been modernized through the use hydroponic production of potato minitubers, which was considered as an alternative to using the traditional technique of using an organic substrate.

Production efficiency is often measured in terms of the rate of minituber production and the number of minitubers produced. It has been proposed that soilless minituber production techniques increase production volume (Rolot & Seutin, 1999).

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 Romania, in recent years there has been increased interest in these unconventional technologies culture that open attractive prospects for professional growers (Atanasiu, 2007).

Crops "without soil" have as a starting point vitroplantlets. By hydroponics method is envisaged minitubers production of high sanitary quality. The main objective is to increase quality and lower production costs.

Hydroponic systems can be passive or active. An active system includes a mechanical agent for recirculating nutrient solution, while passive systems is based on capillary action, absorption and/or gravity feeding of roots with nutrients (Atanasiu, 2007). Hydroponic system has the advantage that the supply of nutrients can be more stable than on soil use and can be adjusted very quickly to the needs of the plant (Lommen, 2007).

The introduction of this technology has decreased the number of field generations required for seed production and reduced exposure of seed tubers to pathogens, thus improving seed quality (Yang, 2004).

Minitubers are free of pathogenic agents being obtained by multiplication of regenerated plantlets (found healthy by ELISA) from meristematic culture.

The advantages of hydroponics system compared to the classical method of producing minituber (Rolot et al., 2002) are: increasing the number of minitubers/unit area; obtaining, a satisfactory proportion of minitubers size, allowing their use in field; obtaining minitubers with an excellent sanitary quality; possibility of complete automation of composition and distribution of nutrient solution; slight possibility of changing the composition of nutrient solution in order to obtain a quality productions in

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sanitary and economical terms (Rolot et al., 2002).

MATERIAL AND METHODS

The starting point is represented by meristem culture (Figure 1). These are taken from potato tubers sprouts and inoculated on a specific medium (Murashige and Skoog, 1962), enriched with vitamins and growth regulators. Plantlets development of these small meristems (with the dimensions of 0.1-0.2 mm to obtain material free of virus) takes from four to eight months in function of genotype. For the evaluation of phytosanitary status of *in vitro* multiplied plantlets DAS ELISA test is made. Clones infected are removed and multiplying is continued of the healthy ones. The plantlets were planted in hydroponic system in protected space "insect-proof" of the National Institute of Research and Development for Potato and Sugar Beet Brasov, Laboratory of Vegetal Tissue Culture and contained variants shown in Table 1.

The experimental variants were studied as shown in Table 1; bifactorial experience, type 4 x 2, made by combining two experimental factors, in which the number of variants studied was 8 and the number of repetitions was 5.

Data were statistically analysed using MSTAT-C program, and to determine significance, difference between mean values were compared with LSD.

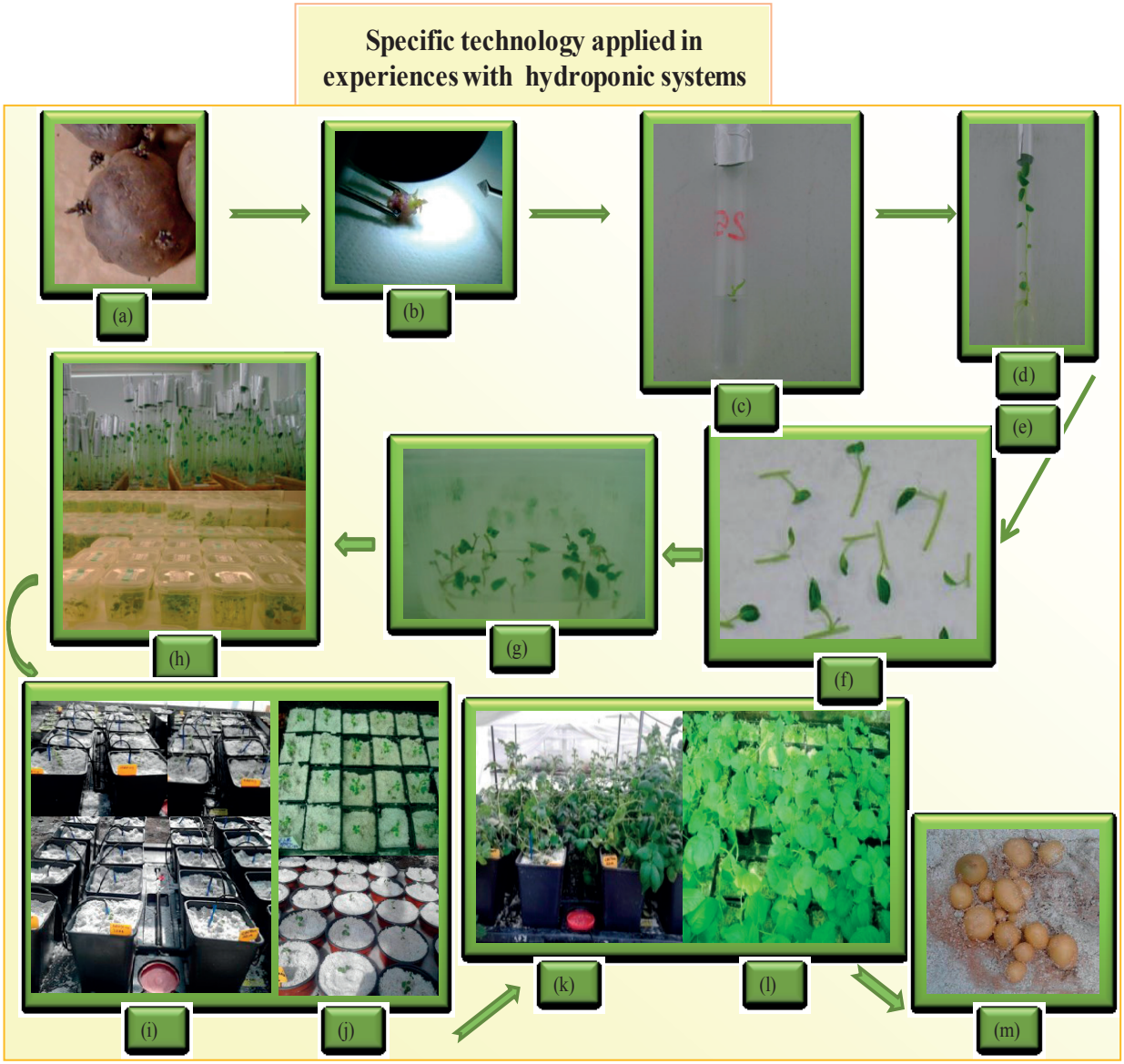

Figure 1. Scheme of minitubers production of Romanian varieties in "insect proof" space by using hydroponic method

where:

a): Selecting varieties and tubers for sprouting, followed by tubers sprouting in specific laboratory conditions;

b): Meristematic sampling under sterile conditions;

c): Meristematic explant inoculation - each explant receives a number, which is a clone of the variety to which tubers sprouts belonged;

d): Regeneration of plantlets (after 4-8 months) from meristematic explants (after 2-3 subcultures of these);

e): Making ELISA test for determination of phytosanitary status of plantlets, after which the infected material is eliminated;

f): The multiplication of healthy clones to obtain the required number of plantlets (microcuttings);

g): Inoculation of microcuttings in culture vessels;

h): Plantlets developing in growing room;

i): Planting in protected "insect - proof" space of plantlets in hydroponic system with circulating nutrient solution;

j): Planting in protected "insect - proof" space of plantlets in hydroponic system with static stratum of nutrient solution;

k): Development of plantlets in hydroponic system with circulating nutrient solution;

l): Development of plantlets in hydroponic system with static stratum of nutrient solution;

m): Obtaining minitubers.

Table 1. The experimental variants in hydroponic system

Variant	Cultivar (a)	Hydroponic system used (b)
V_1	Braşovia	Culture on circulating nutrient solution
V_2		Culture on static layer of nutrient solution
V_3	Castrum	Culture on circulating nutrient solution
V_4		Culture on static layer of nutrient solution
V_5	Marvis	Culture on circulating nutrient solution
V_6		Culture on static layer of nutrient solution
V_7	Sarmis	Culture on circulating nutrient solution
V_8		Culture on static layer of nutrient solution

From Table 1, it follows that bifactorial experience 4 x 2, with 8 variants was performed using the following graduations of studied factors:

– factor A, cultivar, with 4 graduations: a_1 – Braşovia; a_2 – Castrum; a_3 – Marvis; a_4 – Sarmis.

– factor B, type of culture in hydroponic system, with 2 graduations: b_1 – culture on circulating nutrient solution; b_2 – culture on static layer of nutrient solution.

The biological material used in the experiments: plantlets of Braşovia, Castrum, Marvis and Sarmis varieties were used, which were free of virus.

Other materials used in experience: WILMA set (used entirety as a recirculating hydroponic system which can reuse unabsorbed nutrient solution during the process of irrigation) contains: 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;

- solid substrate for plant rooting consists of inert inorganic materials obtained by industrial simple processes: perlite (Figure 2);

Figure 2. Industrial substrate:perlite

- fertilizers: nutrient solutions for culture without soil (prepared on the basis of soluble fertilizer “Universol" manufactured by Scotts – Netherlands), foliar fertilizers Cropmax, Agroleaf, calcium nitrate to correct the response of the nutrient solution (contains total nitrogen: 15.5%, of which ammonium nitrogen: 1.1%, calcium: 19.0% Ca).

A solution of the product "Universol" was prepared (Figure 3). 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).

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

Figure 3. Universol - soluble fertilizer used in experience

RESULTS AND DISCUSSION

Results obtained for the two variants of hydroponic system (Table 2) were interpreted statistically by analysis of variance. The analysed values for the first parameter (the average number of minitubers) were similar, the difference was not significant statistically (-2.90 for minitubers obtained in system with static stratum of nutrient solution).

Table 2. Influence of hydroponic system used on the obtained minitubers number

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

LSD: 5% = 2.96 minitubers; 1%= 4.90 minitubers; 0.1% = 9.17 minitubers.

For the two types of systems in which minitubers were produced (Table 3), the difference in the system with static stratum of nutrient solution reached 45.58%, compared to the circulating system, the negative difference being very significant (-31.52 g/plant).

Table 3. Influence of hydroponic system used on the weight of minitubers obtained/plant

Hydroponic system	The average number 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

LSD: 5%=7.05 g; 1%=11.67 g; 0.1% = 21.83 g.

Hydroponic method application (including the two variants) had no beneficial effect for the variety Braşovia (a reduced number of minitubers/plant: 5.10). Castrum variety recorded higher values of average number of minitub./plant: 11.00, followed by Marvis variety: 10.20 minitubers/plant (without significant difference) (Table 4).

Table 4. The influence of variety on the average number of minituber obtained and the average weight of minitubers / plant in hydroponic system

Variety	The average number of minitubers produced/plant	The average weight of minitubers produced/plant (g)
Brasovia	5.10 C	31.54 BC
Castrum	11.00 A	28.57 C
Marvis	10.20 A	74.03 A
Sarmis	7.10 B	34.46 A
	LSD = 1.64 minitubers	LSD = 3.475 g

Values in the same column followed by the same letters are not significant, according to Duncan test ($p \leq 0.05$).

In terms of minitubers weight/plant Marvis variety is distinguished (74.03 g), followed by Sarmis variety (34.46 g) (with no statistical difference). Castrum and Braşovia varieties differed from Marvis and Sarmis varieties on this parameter without a significant differentiation between Braşovia and Castrum varieties.

Analysis of the combined hydroponic system used and the variety, situate Marvis variety (13.80 minitubers/plant) in first place in case of system solution circulating for number of minitubers/plant, followed by variety Castrum, which in both systems got the same mean number of 11 minitubers/plant (Table 5).

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

Hydroponic system	Variety	Number of minituber obtained/plant	Mean weight of minitubers obtained/plant (g)
System with circulating nutrient solution	Brasovia	6.40 CD	40.70 B
	Castrum	11.00 B	38.81 B
	Marvis	13.80 A	121.60 A
	Sarmis	8.00 C	30.50 C
System with static stratum of nutrient solution	Brasovia	3.80 D	22.38 DE
	Castrum	11.00 B	18.31 E
	Marvis	6.60 C	26.44 CD
	Sarmis	6.20 D	38.42 B
		LSD = 2.758 minitubers	LSD = 5.844 g

Values in the same column followed by the same letters are not significant, according to Duncan test ($p \leq 0.05$).

In the system with circulating solution, Marvis variety (121.6 g), formed minitubers with highest average weight, suggesting that this system has a beneficial effect in producing minitubers with mean weight higher than the static system solution. The circulating solution system determined for Braşovia (40.70 g) and Castrum (38.81) varieties an increase in the average weight compared to static system solution, which caused a sharp decrease of minituber weight/plant (28.38 g for Braşovia variety and 18.31 g variety Castrum).

The weight of minitubers for Braşovia (40.70 g) and Castrum (38.81 g) in the system with circulating nutrient solution was similar with that found in Sarmis (38.42 g) in the system with static nutrient solution stratum.

The influence of the type of hydroponic system applied on the average number of minitubers obtained and on minitubers weight for the tested varieties is shown in Figure 4. In case of hydroponic system with nutrient solution circulating, it can be remarked superiority of Marvis variety.

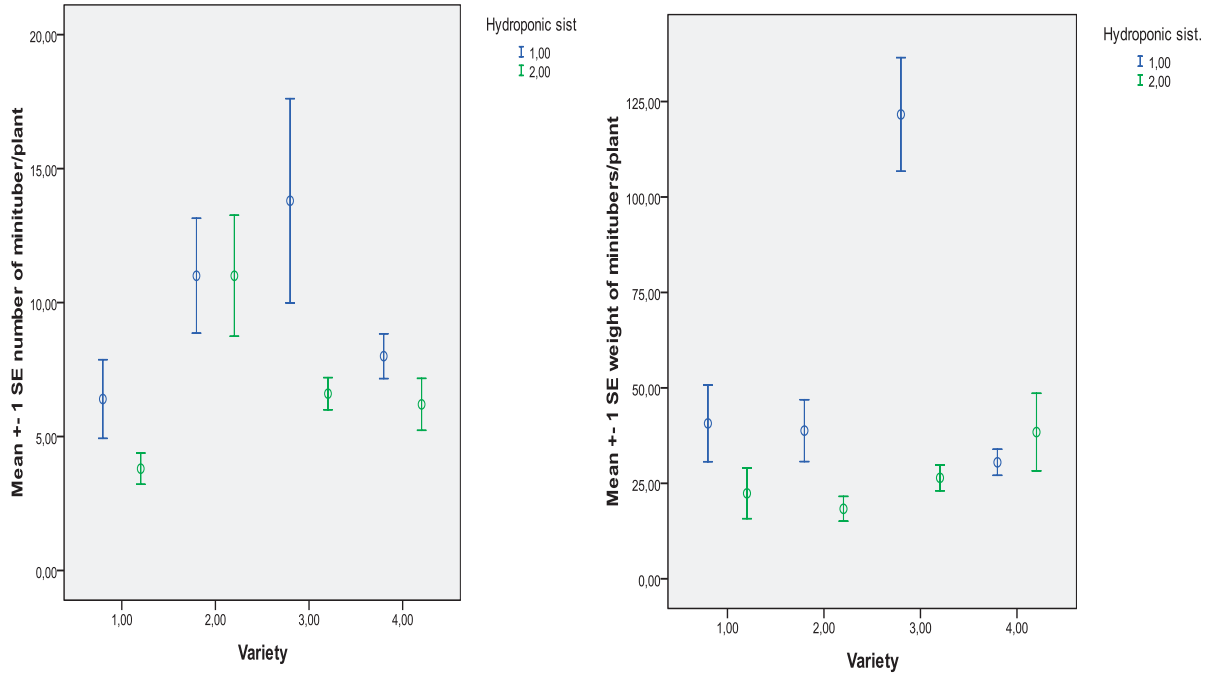

Figure 4. Mean number of minitubers/plant and mean weight of minitubers/plant (g)
(Error bars report standard error for the mean number of minitubers/plant and the mean weight of minitubers/plant)

CONCLUSIONS

Culture "without soil" quickly gained popularity, being the fastest production sector in agriculture. Although initial capital costs of setting up culture "without soil" (like the whole technology) are now barriers, in the long run the costs will decrease, making this option more feasible.

Using this methodology, the number of minitubers/plant is influenced by the hydroponic systems used, having higher values in the system with circulating solution for three of the analysed varieties (Braşovia, Marvis, Sarmis), while the variety Castrum registered the same value in both types of system (11).

From the obtained data we recommend using hydroponic system with circulating nutrient solution. This variant of hydroponic system had also a positive impact on the mean weight of minitubers/plant for Marvis variety, which recorded the highest value (121.60 g).

To be a successful activity and for the harvested material to have a high biological value, respecting, nutritive solution is essential, being the most important factor for achieving this.

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