THE STUDY OF *LYCOPERSICUM ESCULENTUM* ROOTING IN AERO-HYDROPONIC SYSTEM

Vârban Dan Ioan*, Baci Florin*, Rodica Vârban[*], Cristina Moldovan*

*University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Agriculture, 3-5 Manastur, 400372 Cluj-Napoca, Romania, e-mail: rvarban@yahoo.com

Abstract

The base principle in an aero-hydroponic system is to grow the plants suspended into a closed or half-closed environment, by pulverizing the suspended roots with a mixture of water and water-soluble nutrients, while the aerial part develops on top. The study was performed between 9th April – 7th May 2015 in the USAMV Cluj-Napoca's Greenhouse. For the experiment rooted tomato seeLSDings were used and three treatment variants were studied: V1 – rooted tomato seeLSDings; V2 – tomato seeLSDings with chopped roots and treated with gel; V3 - tomato seeLSDings with chopped roots and not treated. After one week from the experiment's start, the tomato plants with chopped roots have formed new roots with lengths of 3.83 cm (V3) and 2.25 cm (V2). The root's length is greater for the chopped roots treated with gel compared to the ones not treated, data being statistically significant in favour of the treated variant.

Key words: *Lycopersicum esculentum*, aero-hydroponic, gel, root's length

INTRODUCTION

In 1942, W. Carter was the first person to study the aerial culture of plants and has described the methods whereby the plants may be cultivated in water vapours to facilitate the study of roots, and in 1957 F. W. Went has named the "aerially" cultivation process as aero-hydroponic, by cultivating coffee and tomatoes of which the roots have grown suspended, by applying fertilizers as vapours.

The base principle in an aero-hydroponic system is to grow plants suspended into a closed or half-closed environment by pulverizing the roots of the suspended plants with a mixture of water and water-soluble nutrients, while the aerial part develops on top (Jones Jr., 2007, Arteca, 2014). The plants roots are separated from the aerial part by a support structure, often made of a spongy material, such as a neoprene ring, in which the plant's stalk is inserted in the root collar area, followed by the insertion of cultivation medium (Waisel et al., 2002, Schwarz, 2002).

For this experiment an aero-hydroponic system of low pressure was used, for its fair price and easiness of execution.

MATERIAL AND METHOD

The study was performed between the 9th April – 7th May 2015 in the USAMV Cluj-Napoca's Greenhouse.

For executing the closed environment, two cuve of 60 litres and one 20 litres tank were used, of black coloured plastic, to ensure that the light is not let in the interior of the roots growing medium and the tank.

Prior starting the system, the tank was filled with 20 litres of water and 2 more litres on the bottom of each dish. Also, water-soluble fertilizers and a negative pH regulator were added.

Afterwards, the tomatoes seeLSDings were settled in the neoprene ring.

At the system's start, the timer was set for the pump to operate for 30 minutes, and then break for 30 minutes. One of the aspects that influenced this decision was due to the temperature's significant rise during the day; switching the ratio from 1:1 to 1:3 (meaning 15 minutes pump running and 45 minutes break) may have caused the roots to dry, hence the dehydration of the plants (Fig. 1 and 2).

For this experiment, water-soluble fertilizer Flora Gro (NH_3 1%, NO_3^-2%, P_2O_5 1%, K_2O 6%, MgO 0.8%) was used, and rootling gel (Clonex – Rooting hormone), which contains 4-indol-3-yl butyric acid, in proportion 3 g per litre (Fig. 3 and 4).

Rootled tomatoes seeLSDings were used for the experiments, three treatment variants being taken into study:

V1 – rooted tomatoes seeLSDings;

V2 – tomatoes seeLSDings with chopped roots and treated with gel;

V3 – tomatoes seeLSDings with chopped roots and not treated.

During the experiment, a single indicator was monitored: the root's length. Readings of this parameter were performed on the 16th of April (D1), 23rd of April (D2), 29th of April (D3) and 7th of May (D4).

Figure 1. Roots pulverization system

Figure 2. Complete aero-hydroponic system

Figure 3. Water-soluble fertilizer

Figure 4. Rootling gel

During the experiment, the parameters were monitored with the measuring equipment Hannah Combo HI 98129, which monitors the pH, electro conductivity and water temperature. This monitoring was necessary in order to optimize the applied fertilizer dose and set the pH level within the optimum limits.

RESULTS AND DISCUSSIONS

Taken as witness the variant for which the plants roots are chopped (without applying the gel), it is noticed that significant growths take place in the roots length compared to the other 2 variants (Table 1). According to the Duncan test, between the three studied variants, significant differences are observed.

Table 1

Treatment influence on the tomato root length (Vârban D., 2015)

Variant	Treatment	Root length		±Difference	Significance	Duncan Test
		(cm)	%			
V3 (Control)	Chopped root with no gel	12.58	100.0	-	-	a
V1	Not chopped root	22.92	182.1	10.33	***	b
V2	Chopped root with gel	16.29	129.5	3.71	***	c

LSD (p 5%) = 1.08 LSD (p 1%) = 1.43 LSD (p 0.1%) = 1.85

The root's length is directly correlated with the rootling duration. Very significant values are recorded 14 days after the treatment. The highest value is recorded 28 days after starting the experiment, the average root length reaching 35 cm. The Duncan test shows that there are significant differences between the four studied variants (Table 2).

Table 2

Experiment duration influence on the tomato root length (Vârban D., 2015)

Variant	Experiment duration	Root length		±Difference	Significance	Duncan Test
		(cm)	%			
V1 Witness	16 April 2015	4.56	100.0	-	-	a
V2	23 April 2015	10.81	237.2	6.25	***	b
V3	29 April 2015	19.06	418.3	14.5	***	c
V4	7 May 2015	34.64	760.4	30.08	***	d

LSD (p 5%) = 1.02 LSD (p 1%) = 1.38 LSD (p 0.1%) = 1.82

As regards to the factors interaction treatment x treatment duration, it is noticed that for the variants with full root and those for which gel was applied, very significant positive values are recorded. The best results are recorded for the plants with full root (7.58 – 44.75 cm). It is noticed from Table 3 that after a week from starting the experiment, the tomatoes plants with chopped root form new roots, with lengths of 3.83 cm (V3) and 2.25 cm (V2). After this date, the length of the root for the chopped gel treated variant (V2) records very significant values on the control (V1).

Table 3

Interaction treatment x treatment duration influence on the tomato root length (Vârban D., 2015)

Treatment	Experience duration	Root length		±Difference	Significance
		(cm)	%		
Chopped root without gel (Control – V3)	16 April 2015 (D1)	3.83	100.0	-	-
Non chopped root (V1)	16 April 2015 (D1)	7.58	197.8	3.75	***
Chopped root with gel (V2)	16 April 2015 (D1)	2.25	58.7	- 1.28	-
Chopped root without gel (Control – V3)	23 April 2015 (D2)	7.58	100.0	-	-
Non chopped root (V1)	23 April 2015 (D2)	13.50	178.0	5.92	***
Chopped root with gel (V2)	23 April 2015 (D2)	11.33	149.5	3.75	***
Chopped root without gel (Control – V3)	29 April 2015 (D3)	13.75	100.0	-	-
Non chopped root (V1)	29 April 2015 (D3)	25.83	187.9	12.08	***
Chopped root with gel (V2)	29 April 2015 (D3)	17.58	127.9	3.83	***
Chopped root without gel (Control – V3)	7 May 2015(D4)	25.17	100.0	-	-
Non chopped root (V1)	7 May 2015 (D4)	44.75	177.8	19.58	***
Chopped root with gel (V2)	7 May 2015 (D4)	34.00	135.1	8.83	***

LSD (p 5%) = 2.17 LSD (p 1%) = 2.87 LSD (p 0.1%) = 3.71

By analysing the interaction duration x treatment according Table 4 it is noticed that the root's length records very significant growths directly with the increase of rootling duration, for all three experimental variants.

Table 4

Interaction duration x treatment influence on the tomato root length (Vârban D., 2015)

Experiment duration	Treatment	Root lenght		±Difference	Significance
		(cm)	%		
16 April 2015 (D1 - Control)	Non chopped root (V1)	7.58	100.0	-	-
23 April 2015 (D2)	Non chopped root (V1)	13.50	178.0	5.92	***
29 April 2015 (D3)	Non chopped root (V1)	25.83	340.7	18.25	***
7 May 2015 (D4)	Non chopped root (V1)	44.75	590.1	37.17	***
16 April 2015 (D1 - Control)	Chopped root with gel (V2)	2.25	100.0	-	-
23 April 2015 (D2)	Chopped root with gel (V2)	11.33	503.7	9.08	***
29 April 2015 (D3)	Chopped root with gel (V2)	17.58	781.5	15.33	***
7 May 2015 (D4)	Chopped root with gel (V2)	34.00	1511.1	31.75	***
16 April 2015 (D1 - Control)	Chopped root without gel (V3)	3.83	100.0	-	-
23 April 2015 (D2)	Chopped root without gel (V3)	7.58	197.8	3.75	***
29 April 2015 (D3)	Chopped root without gel (V3)	13.75	258.7	9.92	***
7 May 2015 (D4)	Chopped root without gel (V3)	25.17	656.5	21.33	***

LSD (p 5%) = 2.05 LSD (p 1%) = 2.72 LSD (p 0.1%) = 3.53

CONCLUSIONS

One week after the experiment started, the tomatoes plants with chopped roots form new roots with lengths of de 3.83 cm (V3) and 2.25 cm (V2).

The variance analysis of the 3 treatments revels the fact that tomatoes plants with full roots (treatment 1) – outperformed the other treatments used.

The length of the root is greater for the tomatoes plants with chopped root and treated with gel, then for the one not treated, the data being statistically significant in favour of the treated ones.

The root's length is directly correlated with the rootling's duration.

The aero-hydroponic systems may be a viable alternative to vegetable's cultivation in vertical systems, bordering urban concentrations or even in their centres.

Through monitoring and constant recirculation of water with nutrients, classic agricultural pollution is avoided, the excess fertilizers being detained from entering the phreatic waters or rivers, thus avoiding the issues connected to such cases.

REFERENCES

1. Arteca, R. N. (2014). Introduction to Horticultural Science. Cengage Learning.
2. Jones Jr, J. B. (2007). Tomato plant culture: in the field, greenhouse, and home garden. CRC press.
3. Raviv M., J. Hienrich Lieth, 2008, *Soiless Culture: Theory to Practice*, Elsevier, Marea Britanie;
4. Schwarz, M. (2012). Soilless culture management (Vol. 24). Springer Science & Business Media.
5. Waisel, Y., Eshel, A., Beeckman, T., & Kafkafi, U. (Eds.). (2002). Plant roots: the hidden half. CRC Press.
6. ***DiksonD.,TEDxWindyCity,"*Theverticalfarm*" https://www.youtube.com/watch?v=XIdP00u2KRA
7. ***Gertjan M., TEDxBrainport 2012, "*Indoor Farming Plant Paradise*" https://www.youtube.com/watch?v=ILzWmw53Wwo
8. ***"*Americ a Shrinking Farms*" https://www.youtube.com/watch?v=QadIFIboOvc
9. *** http://www.nasa.gov/vision/earth/technologies/aeroponic_plants.html
10. *** http://aerofarms.com/why/technology/
11. ***http://www.towergarden.com/content/towergarden/en-us/what-is-tower-garden/how-it-works/aeroponics.html#.VWTrkU-qqko
12. ***http://www.plantlab.nl/
13. ***http://www.flychicago.com/ohare/en/aboutus/sustainability/aeroponic-garden.aspx