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EFFECT OF SUBSTRATES ON NUTRIENT CONTENT IN ROOT ZONE AND LEAVES OF GREENHOUSE TOMATO

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Abstract. The fact that the greenhouse has got fertigation equipment allows for taking apply of various organic materials as substrate. Organic substrata applied in greenhouse cultivations, as compared with rockwool, are biodegradable and as a post-cultivation waste not destroy the natural environment. This research was conducted in glasshouse in the years 2008–2009. The tomato of Admiro F_1 cultivar in the period from February to October for 22 clusters at the density of 2.4 plants for 1 m^2. The treatment consisted of four substrata: 1) rape straw, 2) rape straw + high peat (3 : 1 v : v), 3) rape straw + pine bark (3 : 1 v : v), 4) rockwool (100 × 20 × 7.5 cm = 15 dm^3). Straw was cut into pieces (2–3 cm) and placed in boxes 14 cm high, width: 8 cm and capacity 15 dm^3. During the growing period after 33 weeks about 60% straw has been decomposed. Drop fertigation was applied in a closed system, without nutrient solution recirculation. In the period cultivar of tomato only in the first weeks in organic substrata a decrease in mineral nitrogen content was reported (albumization), but in cannot affect the plant growth because every day nutrient solution was supplied to plants 9–11 times. The content of $N\text{-}NH_4$, $N\text{-}NO_3$, K, Ca, Mg and EC in organic substrates did not significantly differ, compared to rockwool. in both study years. This experiment suggests that the nutrient solution for tomato cultivar in organic substrates was may be similar like that in rockwool.

Key words: rape straw, rockwool, root environment, tomato

INTRODUCTION

The appropriate growth of greenhouse-grown plants, as well as achieving high yield require continuous supplying them with all nutrients in optimal degree. Thus, there is the need to perform methodical chemical analyses of the substratum for diagnostic purposes.

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The appropriate interpretation of analysis results is possible when samples are collected correctly. Other results will be obtained when solution is taken from root zone compared to the results of substratum sample analysis. [Sonneveld and Voogt 2001].

Applying fertigation allows for exact dosing of the growing medium to the grown plants. Comparing the nutrient content in various substrates (sand, mine material of volcanic origin, rockwool, wood fiber, peat, coir) a significant differentiation was demonstrated, despite application of the same medium [Nurzyński 2005, Choi et al. 2007, Miccolis et al. 2007, Komosa et al. 2010].

The most information about the appropriate nutrition of greenhouse tomato can be obtained by performing chemical analyses for nutrient content in the substratum. Regardless of these results also the determination of pH and EC values is needed. For tomato the substratum reaction should range from 5.8 to 6.0 pH [Dyśko et al. 2009, Kang et al. 2011]. Salt concentration, i.e. the EC value during tomato vegetation ranges from 1.5 to 6.0 $mS \cdot cm^{-1}$ and depends, among others, on the kind of substratum. Lower ion concentration is more advantageous for plants – to 3.0 $mS \cdot cm^{-1}$ [Kohsla and Papadopoulos 2001, Buck et al. 2008]. The increase of EC value in the medium causes the decrease of fruit yield, but it also improves the taste, increases the contents of dry matter, soluble solids and titratable acidity [Tuzel et al. 2001].

Tomato needs all the nutrients, but nitrogen and potassium are mentioned as especially important. Regardless of their doses the appropriate N : K proportion must be maintained. Tomato needs more potassium than nitrogen, but applying high doses of that element causes disturbances in the uptake of other ions, including mainly magnesium, calcium, and boron, which negatively affects fruit quality. Thus, in the medium the nitrogen: potassium ratio should be 1N : 1,5–1,7 K [Gent 2004, Caretto et al. 2008, Huang and Snapp 2009] .

In growing tomato in both organic and mineral substrata the contents of nutrients changes during vegetation, whereas slight differentiation is noticed in leaves. Therefore, substrata should be analyzed frequently, at least once a month [Nurzyński et al. 2001, Choi et al. 2007, Komosa et al. 2010].

The aim of the presented paper were studies on the changed contents of N, P, K, Ca, Mg in the root zone and in the leaves of greenhouse tomato grown in substrates: cut rape straw, mixture of rape straw with peat and pine bark, compared to rockwool.

MATERIAL AND METHODS

Studies were conducted in the greenhouse of Department of Soil Cultivation and Fertilization of Horticultural Plants, University of Life Sciences in Lublin. The tomato of Admiro F_1 cultivar was grown in the period from 10th February to 21st October 2008 and from 4th February to 15th October 2009 for 22 clusters at the density of 2.4 plants per $1m^2$. The following substrata were examined: 1) rape straw, 2) rape straw + high peat (3:1 v:v), 3) rape straw + pine bark (3:1 v:v), 4) rockwool (100 × 20 × 7.5 cm = 15 dm^3). Straw was cut into pieces (2–3 cm) and placed in rectangular boxes 14 cm high, bottom width: 8 cm and capacity 15 dm^3. During the growing period about 60% straw has been decomposed. Evaluation of straw decomposition was done by comparing the weight of air dry weight of straw before the experience with the mass after the experiment (after removal of roots). In each box/slab two plants grew. The experiments were conducted with the use of complete randomization method in seven repetitions.

Drip fertigation method was applied in closed system without recirculation of nutrient solution that contained (mg·dm^{-3}): N-NO_3 – 210, P-PO_4 – 54, K – 340, Ca – 250, Mg – 80, Cl – 20, S-SO_4 – 150, Fe – 2.0; Mn – 0.95; B – 0.54; Cu – 0.09; Zn – 0.56; Mo – 0.09. In the period of high temperatures the nutrient solution was applied in the daily amount of about 4.2 dm^3 per plant in 10–12 single doses with 20% nutrient solution effusion from the box/slab. *Bombus terrestris* used for plant pollination, Greenhouse Whitefly (*Trialeurodes vaporariorum*) was biologically controlled with *Encarsia formosa*.

Chemical analyses of substrates (solution from the root zone) using the following methods: N-NH_4 and N-NO_3 by disstilation according to Bremner in Starck's modification, P- colorimetrically with ammonium vanadomolybdate (Thermo, Evolution 300), K, Ca, Mg by ASA (Perking-Elmer, Analyst 300), EC – conductometrically, pH – potentiometrically.

Samples of nutrients representing the root zone were taken with using the syringe in mid-distance between the plants, along the centra axis of the slab by injecting the syringe needle into one half of slab thickness (rockwool) and 2 cm above of bottom of the box (organic substrates).

Samples of leaves (8th leaf from the top) were determined: N-total using Kiejdahl's method (Tecator), P, K, Ca, Mg were measured by methods for substrates. The contents in substrates and in leaves were analyzed once a month (substrates eight times, leaves six times during vegetation season).

Statistical elaboration of results was conducted using the method of variance analysis on mean values, applying Tukey's test for assessing differences, at significance level of $\alpha = 0.05$.

RESULTS

In the presented studies organic substrates and rockwool were applied. Straw, peat and bark during tomato vegetation undergo systematic decomposition, supplying plants with small amounts of mineral components. Mean nutrient contents in substrata during two years of studies changed to a small extent, and significant differences were also demonstrated (tab. 1). The contents of N-NH_4 were in the optimum range (ca. 10% of mineral nitrogen), but there was significantly less of that nitrogen form in rockwool. No significant differences were found between the organic substrates and rockwool. The smallest quantity of that nitrogen form was found in the rape straw + pine bark substratum. The contents of phosphorus, potassium and calcium in organic substrates was similar, whereas there was significantly less of those components in rockwool. It confirms that as a result of organic material mineralization plants obtain additional nutrients. Magnesium contents in all the substrates were optimal, no significant differences were found. Despite a certain differentiation of the nutrient content in the examined substrates, salt concentration (EC) was in the optimal interval throughout the whole vegetation period (tab. 1, fig. 1). The EC value is a good indicator, used in diagnosing plant nutritional needs.

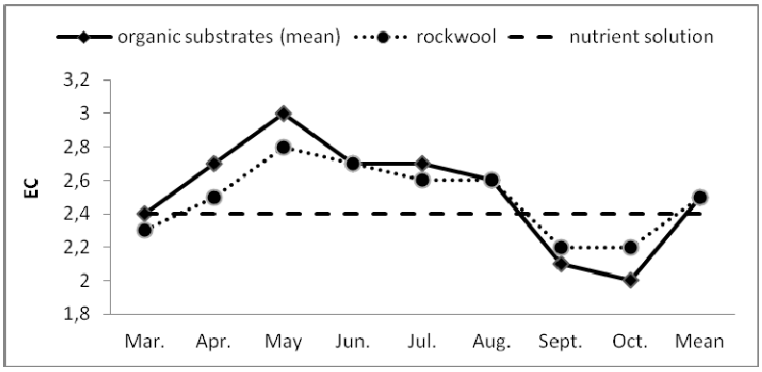

Fig. 1. EC in substrates (the solution from the root zone) and in nutrient solution (mS·cm^{-1}) during vegetation season. Mean 2008–2009

Table 1. The nutrient content in substrates (mg·dm^{-3} of solution from the root zone) and EC (mS·cm^{-1})

Substrates	Years	$N\text{-}NH_4$	$N\text{-}NO_3$	$P\text{-}PO_4$	K	Ca	Mg	EC
Rape straw	2008	16.3	264.3	87.3	336.5	321.2	103.0	2.8
	2009	38.0	233.9	60.6	319.4	314.4	103.9	2.3
	mean	27.1a	249.1a	73.9a	327.9a	317.8b	103.4b	2.5a
Rape straw + peat	2008	23.3	247.8	89.2	335.0	315.6	98.0	2.8
	2009	34.9	233.0	61.8	316.6	314.2	115.3	2,4
	mean	29.1a	240.4b	75.5a	325.8a	314.9bc	106.6b	2.6a
Rape straw + pine bark	2008	22.5	257.8	84.3	331.4	330.2	109.1	2.7
	2009	32.9	238.4	64.1	325.8	336.2	114.9	2.3
	mean	27.7a	248.1a	74.2a	328.6a	333.2a	112.0b	2.5a
Mean for organic substrates		28.0a	245.9ab	74.5a	327.4a	322.0b	107.4b	2.5a
Rockwool	2008	18.5	252.2	76.1	346.0	292.2	94.9	2.7
	2009	29.6	248.0	57.5	278.6	302.9	113.0	2.3
	mean	24.0b	250.1a	66.8b	312.3b	297.5c	103.9b	2.5a

Means in the column followed the same letter are not significant different at α = 0.05

Interesting relationships were found in $N\text{-}NO_3$ contents in the examined substrates during tomato vegetation period (fig. 2). At the beginning of growing (Mar., Apr.), because of biological sorption in organic substrates, the content of mineral nitrogen decreases. The chemical composition of the medium was the same during the whole vegetation period. Despite low nitrogen content in March (95 mg $N\text{-}NO_3 \cdot dm^{-3}$), the growth was normal, as the medium was supplied to plants 7–9 times a day. Besides, at the beginning of growing tomato needs a lot of nitrogen, which is confirmed by rockwool analysis. In the subsequent months of growing the contents of $N\text{-}NO_3$ in all the examined substrates were more than 210 mg $N\text{-}NO_3\cdot dm^{-3}$, so it was more than in the nutrient solution. What draws our attention here, is the highest contents of $N\text{-}NO_3$ in the substrates in May, June and July. At that time the air temperature in the greenhouse was high (up to 40ºC) and fertigation was activated more frequently (14 times a day). In this way more mineral salts were supplied to the substrates.

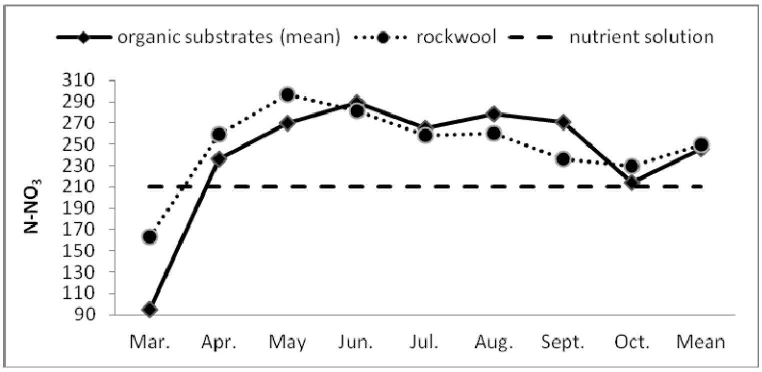

Fig. 2. The $N\text{-}NO_3$ content in substrates ($mg\cdot dm^{-3}$ of solution from the root zone) and in nutrient solution ($mg\cdot dm^{-3}$) during vegetation season. Mean 2008–2009

In tomato growing nutrition with calcium is very important, because the content of this component in fruit must be optimal. During vegetation calcium contents in organic substrates and in rockwool was correct, above its content in the nutrient solution (fig. 3). Most of that component was there in the summer months, which is valuable, because the highest yield is obtained at that time.

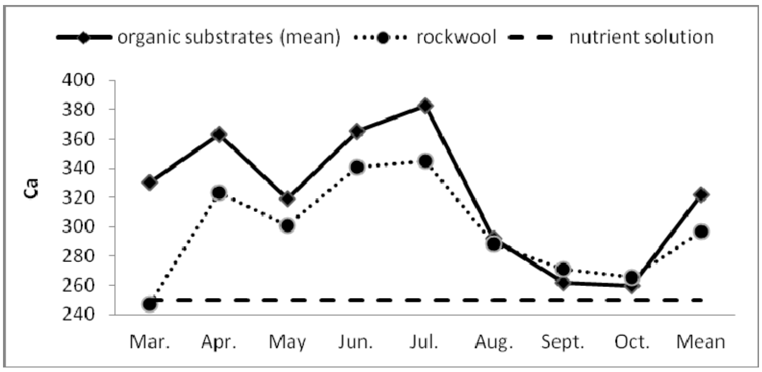

Fig. 3. The Ca content in substrates ($mg\cdot dm^{-3}$ of solution from the root zone) and in nutrient solution ($mg\cdot dm^{-3}$) during vegetation season. Mean 2008–2009

The stability of pH values in the solution from the root zone should be emphasized. Concentrated acids (HNO_3, H_3PO_4) added to the medium, prevented alkalization of the root zone, thanks to which, except the beginning of growing (Mar., Apr.), when there was 6.9–7.6 pH, in the next months pH was 5.8–6.3.

Regardless of substrates analysis, also the nutrient content in leaves is important. In the conducted studies 8th leaf from the top was considered, determining the contents of N, P, K, Ca, Mg (tab. 2). Mean total nitrogen content and potassium content in leaves in objects with organic substrates was significantly lower compared to rockwool, so the reverse relationship was obtained compared to the results of substrates analysis. The contents of phosphorus, calcium and magnesium in leaves were not too differentiated.

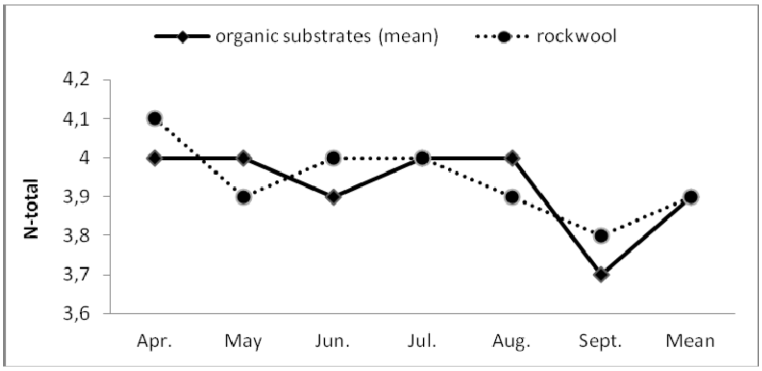

Fig. 4. The nitrogen content of tomato leaves (% d.m.) during vegetation season. Mean 2008–2009

Table 2. The nutrient content of tomato leaves (% of dry matter)

Substrates	Years	N-total	P	K	Ca	Mg
Rape straw	2008	3.92	0.37	4.75	3.47	0.30
	2009	4.14	0.40	4.85	4.14	0.46
	mean	4.03a	0.38a	4.80a	3.80c	0.38a
Rape straw + peat	2008	3.85	0.38	4.37	3.78	0.32
	2009	3.91	0.39	4.38	4.49	0.50
	mean	3.88c	0.38a	4.37d	4.13a	0.41a
Rape straw + pine bark	2008	3.80	0.36	4.50	3.81	0,34
	2009	3.95	0.37	4.54	3.94	0.45
	mean	3.87c	0.36a	4.52c	3.87b	0.39a
Mean for organic substrates		3.93b	0.37a	4.56c	3.94b	0.39a
Rockwool	2008	4.05	0.35	4.81	3.40	0.31
	2009	3.92	0.38	4.56	4.33	0.49
	mean	3.98a	0.36a	4.68b	3.86b	0.40a

Note: see Table 1

During tomato vegetation (Apr. – Sept.) the total nitrogen content decreased, regardless of the kind of substrates, assuming the highest values in March and April, and the lowest in September (fig. 4). This means that tomato needs most nitrogen at the beginning of vegetation period. This is confirmed by the results of nitrogen contents in the substrates where the least $N\text{-}NO_3$ there was in April (fig. 2).

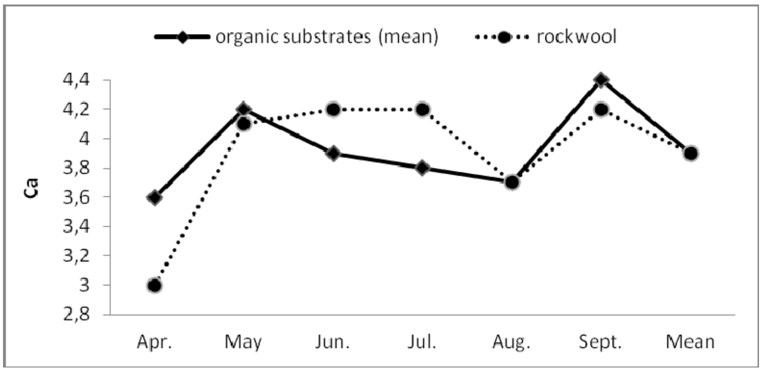

Fig. 5. The calcium content of tomato leaves (% d.m.) during vegetation season. Mean 2008–2009

The contents of nitrogen in leaves seems interesting in particular months of growing (fig. 5). During fruit harvest, when the demand for calcium was the highest, the leaves contained more than 3.6% of this nutrient in dry matter. Regardless of the kind of examined substrates, at the mean calcium contents in leaves (3.9% Ca in d.m.) and in substrates (310 mg $Ca \cdot dm^{-3}$), blossom-end rot did not occur in tomato fruit.

DISCUSSION

Improving the ecological consciousness among consumers, methodical destruction of peatbogs, as well as problems with rockwool management as post-production waste, force horticultural industry to use different organic materials as substrates for plant growing in greenhouses. Scientific studies on the subject are interesting. The usability of in. a. wood fiber, pine sawdust, rye straw, rice hulls, coconut fibre and flax shives was confirmed [Choi et al. 2007, Bassan et al. 2012, Gruda 2012, Kaniszewski et al. 2012].

Regardless of the materials, every substrates must be characterized by physical, chemical and biological stability, among which the water-air proportion is emphasized, as well as the values of pH and EC, and also the chemical composition of nutrient solution from the root zone [Komosa et al. 2009, Verhagen 2009, Dorais and Pepin 2011].

In the presented studies rape straw cut into pieces (2–3 cm), rape straw + high peat and + pine bark were applied as substrate. After 33 weeks (end of experiment) about 60% straw was decomposed. In spite of that, the concentrations in the nutrient solution, collected from the root zone (N, P, K, Ca, Mg), as well as pH and EC remained on the level recommended for tomato, both in organic substrates and in rockwool. Only the contents of $N-NO_3$ in organic substrates at the beginning of growing (Mar., Apr.) were low, which should be explained by biological sorption. Others also obtained similar results [Nurzyński 2006, Domeno et al. 2009, Komosa et al. 2010].

Potassium is an important nutrient for tomato. It positively affects the contents of sugars, vitamin E, carotenes and lycopene in fruit, but when it is luxuriously taken up by plants, it negatively affects the uptake of magnesium, calcium and boron [Gent 2004, Caretto et al. 2008, Ramirez et al. 2012]. Calcium deficiency in plants, caused by potassium antagonism or low calcium concentration in the medium causes the occurrence of blossom-end rot disease on fruit, lowering its quality [Benko et al. 2012].

In the presented studies, thanks to the optimum concentration of calcium in substrates and leaves, and also, thanks to fertigation, appropriate water supply to plants , this disease did not occur on fruit.

A good indicator of ion concentration in nutrient solution and in nutrient solution from the root zone is the value of EC. It is assumed that this value should range from 2,0 to 4,0 $mS \cdot cm^{-1}$. At higher values the tomato fruit yield may decrease, but fruit quality is improved [Tuzel et al. 2001, Buck et al. 2008, Perez et al. 2009, Segura et al. 2009]. In the conducted studies in nutrient solution from the root zone the EC value ranged from 2.0 to 3.0 $mS \cdot cm^{-1}$, assuming the highest values in May and the lowest in September and October. The tendency for changes was the same in all the examined substrates.

Assessing the examined organic substrates (cut rape straw, as well as mixture with peat and pine bark) compared to rockwool slight differences should be emphasized in the chemical composition of these substrates, as well as in the leaves of the grown tomatoes. The applied nutrient solution was the same, but rape straw, peat and pine bark during vegetation underwent decomposition, supplying some mineral components and organic compounds. In the studies on the application of synthetic humine acids and aminoacids [Garcia et al. 2010, Olfati et al. 2010] in growing tomato and cucumber, a positive effect was demonstrated upon the contents of mineral components in plants, but the positive effect upon fruit yield was found when there was the whole set of components in optimal doses in the nutrient solution.

CONCLUSIONS

1. The content of $N-NO_3$ in organic substrates during tomato vegetation like in rockwool ranged from 220 to 290 $mg \cdot dm^{-3}$, except the beginning of growing (March), where 95 (organic substrates) and 160 $mg \cdot dm^{-3}$ (rockwool) were demonstrated.

2. The contents of $N-NH_4$, P, K, Ca in organic substrates were significantly higher compared to rockwool.

3. The EC values in organic substrates and rockwool during the whole tomato vegetation period were optimal according to the levels recommended for tomato.

4. The high yield of tomato fruit grown in organic substrates (cut rape straw and mixture with peat and pine bark) was obtained at average contents in nutrient solution from the root zone ($mg \cdot dm^{-3}$): $N-NH_4$ – 28, $N-NO_3$ – 246, P – 75, K – 328, Ca – 320, Mg – 107.

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REFERENCES

Bassan A., Sambo P., Zanin G., Evans M.R., 2012. Use of fresh rice hulls and anaerobic digestion residues as substrates alternative to peat. Acta Hort. 927, 1003–1010.

Benko B., Borošić J., Poljak M., Osvald J., 2012. Incidence of tomato blossom-end rot at different calcium levels. Acta Hort. 927, 385–392.

Buck J.S., Kubota C., Jensen M., 2008. Effect of mid-day reduction of high electrical conductivity treatment on the yield and quality of greenhouse cherry tomato. Hort. Technol. 18(3), 460–466.

Caretto S., Parente A., Serio F., Santamaria P., 2008. Influence of potassium and genotype on vitamin E content and reducing sugar of tomato fruits. Hort. Sci. 43(7), 2048–2051.

Choi J., Ahn J., Ku J., 2007. Growth and nutrient uptake of tomato plug seedling influenced by elevated blendingrate of perlite in coir and peatmoss substrates. Hort. Envir. Biotech. 48(5), 270–276.

Domeno I., Irigoyen N., Muro J., 2009. Evolution of organic matter and drainages in wood fibre and coconut fibre substrates. Sci. Hort. 122(2), 269–274.

Dorais M., Pepin S., 2011. Soil oxygenation effects on growth, yield and nutrition of organic greenhouse tomato crops. Acta Hort. 915, 91–99

Dyśko J., Kowalczyk W., Kaniszewski S., 2009. The influence of pH of nutrient solution on field and nutritional status of tomato plants grown in soilless culture system. Veget. Crops Res. Bull. 70, 59–69.

Garcia A.L., Madrid R., Gimeno V., Rodriguez Ortega W.M., Nicolas N., Garcia-Sanchez F., 2010. Influence of amino acids in the nutrient solution on the growth and mineral content of tomato plants. Agric. Verg.: Frut. Hort. Flor. Citr. Vid, Arroz 29(337), 157–164.

Gent P.P.N., 2004. Effect of nitrogen and potassium supply on yield and tissue composition of greenhouse tomato. Acta Hort. 644, 369–375.

Gruda N., 2012. Sustainable peat alternative growing media. Acta Hort. 927, 973–979.

Huang J.S., Snapp S.S., 2009. Potassium and boron nutrition enhance fruit quality in midwest fresh market tomatoes. Comm. Soil Sci. Plant Anal. 40(11/12), 1937–1952.

Kang Y.J., Park J.M., Kim S.H., Kang N.J., Park K.S., 2011. Effects of root zone pH and nutrient concentration on the growth and nutrient uptake of tomato seedlings. J. Plant Nutr. 34(5), 640–652.

Kaniszewski S., Dyśko J., Kowalczyk W., Wojtysiak J., Wrocławski Z., Moraczewski A. 2012. Assessment of the changes in the physical properties of fibrous organic substrates in soilless culture of tomato. Acta Hort. 927, 815–820.

Khoshla S., Papadopoulos A.P., 2001. Influence of K:N ratio and EC on tomato plant raising. Acta Hort. 548,149–156.

Komosa A., Piróg J., Kleiber T., 2009. Changes of macro- and micronutrient contents in the root environment of greenhouse tomato grown in fiber wood. Veget. Crop Res. Bull. 70, 71–80.

Komosa A., Kleiber T., Piróg J., 2010. Contents of macro- and microelements in root environment of greenhouse tomato grown in rockwool and wood fiber depending on nitrogen levels in nutrient solutions. Acta Sci. Pol., Hortoroum Cultus 9(3), 59–68.

Miccolis V., Candido V., Lucarelli G., Castronuovo D., 2007. Cherry tomato yield on two different solid growing media. Acta Hort. 761, 573–579.

Nurzyński J., Michałojć Z., Jarosz Z., 2001. Mineral nutrient concentration in potting media (rockwool, peat, sand) and growth of tomato. Veget. Crops Res. Bull. 55,45–48.
Nurzyński J., 2005. Effect of different fertilization levels on yielding of greenhouse tomato grown on sand, peat or rockwool growth media. Veget. Crops Res. Bull. 63, 101–107
Nurzyński J., 2006. The yielding of greenhouse tomato grown in straw and rockwool. Folia Hort. 18/2, 17–23.
Olfati J.A., Peyvast G., Qamgosar R., Sheikhtaher Z., Salimi M., 2010. Synthetic humic acid increased nutrient uptake in cucumber soilless culture. Acta Hort. 871,425–428.
Perez M.L.S., Paris J.J.C., Yasuda R.S., Lao M.T., 2009. Influence of salinity and fertilization level on the nutrient distribution in tomato plants. Commun. Soil Sci. Plant Anal. 40, 498–513.
Ramirez S.L.F., Diaz S.F.R., Muro E.J., 2012, Relation between soilless tomato quality and potassium concentration in nutritive solution Acta Hort. 947, 215–221.
Segura M.L., Contveras J.I., Salinas R., Lao M.T., 2009. Influence of salinity and fertilization level on greenhouse tomato yield and quality. Commun. Soil Sci. Plant Anal. 40, 485–497.
Sonneveld C., Voogt W., 2001. Chemical analysis in substrate systems and hydroponics–use and interpretation. Acta Hort. 548, 247–259.
Tuzel J.H., Tuzel Y., Sul A., Eltez R.Z., 2001. Effects of EC level on the nutrient solution on yield and fruit quality of tomato. Acta Hort. 559, 587–592.
Verhagen J.B.G.M., 2009. Stability of growing media from a physical, chemical and biological perspective. Acta Hort. 819, 135–142.

ZAWARTOŚĆ SKŁADNIKÓW POKARMOWYCH W PODŁOŻACH I LIŚCIACH POMIDORA SZKLARNIOWEGO W OKRESIE WEGETACJI

Streszczenie. Wyposażenie szklarni w aparaturę do fertygacja daje szereg możliwości wykorzystania materiałów organicznych jako podłoży dla uprawianych roślin. Materiały organiczne, w przeciwieństwie do wełny mineralnej, są biodegradowalne i ich zagospodarowanie jako odpadów poprodukcyjnych nie stanowi problemu. Badania przeprowadzono w szklarni w latach 2008 i 2009. Pomidor odmiany Admiro F_1 uprawiano w okresie od lutego do października na 22 grona, w zagęszczeniu 2,4 rośliny na 1 m^2. Badano cztery podłoża: 1) słomę rzepakową, 2) słomę rzepakową + torf wysoki (3:1 obj.), 3) słomę rzepakową + korę sosnową (3:1 obj.), 4) wełnę mineralną (100 × 20 × 7,5 cm = 15 dm^3). Słomę pocięto na kawałki (2–3 cm) i umieszczono w skrzynkach prostokątnych o wysokości 14 cm i szerokości 8 cm (25 dm^3). W każdej skrzynce / na każdej macie rosły dwie rośliny. Po zakończeniu badań (33 tygodnie) ok. 60% słomy zostało zmineralizowane. Stosowano fertygację kroplową w układzie zamkniętym bez recyrkulacji pożywki. W okresie wegetacji pomidora tylko w pierwszych tygodniach odnotowano w podłożach organicznych spadek zawartości azotu mineralnego, co mogło być związane z biologiczną sorpcją azotu, ale nie miało to wpływu na wzrost roślin, gdyż pożywka była dostarczana 9–11 razy na dobę. Zawartość $N\text{-}NH_4$, $N\text{-}NO_3$, K, Ca, Mg oraz wartość pH i EC w podłożach organicznych nie różniła się istotnie w porównaniu z wełną mineralną. Na podstawie otrzymanych wyników można wnioskować, że skład chemiczny pożywki dla pomidora uprawianego w badanych podłożach organicznych może być podobny jak w podłożach z wełny mineralnej.

Słowa kluczowe: słoma rzepakowa, wełna mineralna, roztwór w strefie korzeniowej, pomidor

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