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NUTRITION STATUS OF GREENHOUSE TOMATO GROWN IN INERT MEDIA. Part I. MACROELEMENTS

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Abstract. In the experiments carried out in the years 1998-1999 the effect of inert media and fertilization levels on the nutrition status of greenhouse tomato cv. 'Maeva F_1' was investigated. Two feeding solutions were used: I, containing (in mg dm^{-3}): N-NO_3 – 189, P – 62, K – 371, Ca – 190, Mg – 49, Fe – 0.84, Mn – 1.87, B – 0.32, Zn – 2.01, Cu – 0.048, Mo – 0.048, pH 5.5, EC – 3.2 mS cm^{-1}; and solution II with the concentration increased by 20%, and three inert media: rockwool (Grodan), polyurethane foam (Inert) and expanded clay (granulation 4–8 mm). In the index parts of the tomato (9–10 leaf from the top) the mean content of nutrients was (% in d.m.): N – 3.69, P – 0.41, K – 5.30, Ca – 7.49, Mg – 0.55. No significant effect was found for the studied media – rockwool, expanded clay and polyurethane foam – on the nutrient content in the index parts of the greenhouse tomato, except for phosphorus. Fertilization levels also did not affect significantly content of these nutrients in the index plant parts.

Key words: inert media, soilless culture, fertigation, tomato

INTRODUCTION

The basis of appropriate yielding of greenhouse tomato grown in inert media is correct fertilization. Researchers agree that too high ammonium nitrogen content, over 10% of nitrates content, is inappropriate since it results in excessive vegetative growth and lowers the yield [Hojho et al. 1995]. Wysocka-Owczarek [1998] recommends 190 mg N-NO_3 dm^{-3} of nutrient solution for tomato seedling production, 240 mg N-NO_3 after planting out the plants in the main cultivation, and gradual lowering to 180 mg N-NO_3 in summer.

Adams [1994] points out to the ratio N:K which should be 1:(1.1–2.0). Similar recommendations are given by Wysocka-Owczarek [1998] suggesting the ratio N:K = 1:1.2 at the beginning of cultivation, 1:1.3 during blooming of the 1–3 cluster, and 1:1.6 in summer and autumn. According to Adams [1996] the N:K ratio in the initial period of the cultivation should be 1:(1.1–1.2) and then 1:2.5. This is due to constant plant requirement for nitrogen and increasing for potassium. Komosa et al. [2002] did not find any significant effect of constant and variable N:K ratio on yielding of tomato grown in rockwool.

Potassium content in a nutrient solution should be kept within the range of 210–360 mg K dm^{-3} [Wysocka-Owczarek 1998]. Potassium significantly affects the quality, coloring and ripening of tomato fruits [Adams and Ho 1995]. This nutrient is accumulated in large amounts in the fruits, particularly in older plants [Adams 1993].

Recommended amounts of phosphorus in the tomato nutrition solution are in the range of 30–40 mg P·dm^{-3} [Adams 1994, Wysocka-Owczarek 1998]. For calcium the recommendations are differential. The minimal content according to Adams [1993] and Vogt [1993] is 100 mg Ca dm^{-3}. At a lower calcium content the number of fruits with the blossom-end rot symptoms increases [Massey et al. 1983]. Wysocka-Owczarek [1998] gives higher content – 200 mg Ca dm^{-3} of the nutrient solution. Also the recommendations for magnesium are differentiated; according to Vogt [1993] the sufficient level is 24 mg Mg, Adams [1994] 70–80 mg Mg, and Wysocka-Owczarek [1998] 50–60 mg Mg dm^{-3} of the nutrient solution.

The main objective of this work was to determine the effect of different fertilization levels and kind of inert media on the nutrition status of greenhouse tomato cv. 'Maeva F_1'.

MATERIAL AND METHODS

The experiments were carried out in the years 1998–1999, in the greenhouse of the Agricultural Experimental Station "Piastów", Department of Horticulture, Agricultural University in Wrocław, Poland. The experiments were established by random sub-blocks in four replications. One plot included 8 plants in 4 slabs or in 4 boxes.

The first investigated factor included two levels of nutrients in the feeding solution: (I) the standard feeding solution contained (in mg·dm^{-3}): N-NO_3 – 189, P – 62, K – 371, Ca – 190, Mg – 49, Fe – 0.84, Mn – 1.78, B – 0.32, Zn – 2.01, Cu – 0.048, Mo – 0.048, pH 5.5, EC – 3.2 mS cm^{-1}; and (II) with the concentration increased by 20% [Komosa et Olech 1996]. The second factor included three root media: rockwool (Grodan), polyurethane foam (Inert) and expanded clay (granulation 4–8 mm), 5 dm^{-3} of each medium per plant.

The cultivation was carried out in a drainage fertigation system. The water for fertigation was supplied from a well with the following nutrient composition (in mg dm^{-3}): N-NO_3 – 14.7, P – 1.9, K – 41.8, Ca – 105.0, Mg – 38.1, Na – 40.5, Cl – 47.2, S-SO_4 – 87.4, Fe – 0.259, Mn – 1.783, B – 0.085, Zn – 2.01, Cu – 0.005, Mo – traces, pH 6.82, EC – 1.59 mS cm^{-1}. The slabs and boxes with the expanded clay were placed on low racks (10 cm above floor level) covered with white foil. Nutrient solution was supplied to each plant by a system of pipes, capillaries and emitters with a pressure compensation, the output of the emitter being 35 cm^3 min^{-1}. The composition of stock nutrient solutions was estimated on the basis of water analysis and was prepared as a 100-fold concentration of single and complex fertilizers in two containers A and B of 100 dm^3 capacity each. The stock solution was 1:100 diluted using proportional diluters (Dosatron). The fertigation cycles were adjusted to the plant development stages and steered by the Yarden control program. For the pollination terrestrial bumble bees (*Bombus terrestris*) were used.

The seeds of greenhouse tomato cv. 'Maeva F_1' were sown in mid-January and the seedling planted at the beginning of March. The experiments were concluded on 10 October 1998 and 11 October 1999. The index parts were 9–10 leaves from the top, the samples were taken 4 times during the vegetative season at one month intervals starting from May. The leaves were dried and ground. General forms of macro and microelements were determined. The macroelements were determined after digestion the leaves in H_2SO_4, and the microelements in the mixture of H_2SO_4, HNO_3 and $HClO_4$. Nutrients were determined using the following methods: P – calorimetrically, K, Ca – photometrically, Mg, Fe, Cu, Mn and Zn by AAS. Determination of N-total was done with Kjeldahl method by digestion with sulfosalicilic acid at the presence of catalysts [Breś et al. 1997]. The results were statistically elaborated with the analysis of variance at the significance level $\alpha = 0.05$.

RESULTS

The highest nitrogen content – 4.14% N in the index parts of greenhouse tomato (9–10 leaf from the top) cv. 'Maeva' was found at the first fertilization level in the cultivation in expanded clay, while the mean content from all objects and years of investigation was 3.69% (tab. 1). The fertilization levels did not affect significantly the nitrogen content. Higher mean content – 3.72% N was found at the second fertilization level. Also no significant effect of media on nitrogen nutrition status of the plants was noted. In 1998 mean nitrogen content – 3.97% N – was significantly higher than in 1999 – 3.42% N.

Mean phosphorus content in the index parts of the plants grown in expanded clay was significantly higher than in rockwool and polyurethane foam (tab. 2). The highest phosphorus content – 0.49% P in the index parts of cv. 'Maeva' was found in the plants grown in expanded clay at the second fertilization level in 1998. The fertilization levels did not significantly affect the phosphorus content, however, higher mean content, 0.42% P, was noted at the second fertilization level. Similarly as in case of nitrogen and potassium, a significant effect of the year of cultivation on the phosphorus content was observed. In 1998 the mean phosphorus content, 0.46% P, was significantly higher than in 1999 – 0.36% P.

The highest potassium content – 5.85% K in the index parts of greenhouse tomato cv. 'Maeva' was found in the plants grown in polyurethane foam at the second fertilization level in 1999 (tab. 3). The fertilization levels did not significantly affect the potassium content. Higher mean content – 5.40% K was found at the second fertilization level. The media, as well as the fertilization levels, did not have a significant effect on the potassium content in the index parts, however, the leaves of the plants grown in polyurethane foam revealed its highest content.

Very high calcium content was noted. The mean was 7.49% Ca in the index parts of the tomato (tab. 4). The highest content – 8.22% Ca was found in the plants grown at the first fertilization level in polyurethane foam in 1999. However, the fertilization levels did not affect significantly the calcium content, higher mean content – 7.81% Ca – was found at the first level of fertilization. Also the media did not cause significant differences in calcium contents. The lowest mean Ca content was found in the plants grown in rockwool, higher in polyurethane foam and the highest in expanded clay.

Mean magnesium content in the index parts of the tomato cv. Maeva was 0.55% Mg (tab. 5). The plants grown at the first level of fertilization in polyurethane foam in 1998 indicated the highest content – 0.74% Mg, while the lowest – 0.38% Mg had the plants grown in expanded clay at the second fertilization level in 1999. No significant effect of neither the fertilization level nor media on magnesium nutrition status of the plants was found. The year of study affected the content of this nutrient. In 1998 a significantly higher magnesium content in the index parts was noted than in 1999.

DISCUSSION

Atherton et Rudish [1986] state that nitrogen content in tomato leaves should be included within the range 2.8–4.2% N. In our investigations mean nitrogen content was close to the upper limit of this range – 3.69% N in the index parts. Similar results were reported by Michałojć and Nowak [2000], while much higher – 5.40% N by Kowalska [2000].

Standard phosphorus content in tomato leaves according to Atherton and Rudish [1986] should be 0.40–0.65% P. Similar results were obtained by Sady et al. [1998]. In our investigations the values closer to the lower limit of this range were found – 0.41% P. Definitely higher phosphorus content – 0.88% P – for the tomato grown in rockwool was noted by Nurzyński et al. [2000].

Mean potassium content – 5.30% K in the index parts obtained in this study was close to the content quoted by Sady et al. [1998]. Lower content was found by Nurzyński et al. [2000], Kowalska [2000] and Michałojć and Nowak [2000].

Results of investigations into calcium content reported by various authors are divergent. The authors' own study indicated high content of this componenet, on average 7.49% Ca in the index parts. Similar results are given by Oświecimski [1992]. However, the majority of authors quote lower content, e.g. 2.0% Ca was found by Nurzyński and Michałojć [1998] and Kowalska [2000], 3.3% Ca by Michłojć and Nowak [2000] and Nurzyński et al. [2000]. Even lower content, below 1.0% Ca, was indicated by Sady et al. [1998]. Bergman [1992] stresses that tomatoes belong to the plants able to accumulate large amounts of this component which was also confirmed in our own study.

Magnesium content was on average 0.55% Mg in the index parts and was included in the range reported by Atherton and Rudish [1996] and close to the results obtained by Michałojć and Nowak [2000]. Whereas definitely lower content was noted by Nurzyński et al. [2000].

Table 1. The effect of fertilization levels and inert media on nitrogen content in the index plant part of greenhouse tomato cv. 'Maeva F_1' (% N d.m., mean for terms)

Tabela 1. Wpływ poziomów nawożenia i podłoży inertnych na zawartość azotu w części wskaźnikowej pomidora szklarniowego odmiany 'Maeva F_1' (% N s.m., średnia z terminów)

Years Lata	Level I (B) – Poziom I (B)				Level II (B) – Poziom II (B)				
	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	$\overline{x}$
(A)	(C)	(C)	(C)	(A×B)	(C)	(C)	(C)	(A×B)	(A)
1998	3.89	4.14	3.85	3.96	3.95	3.97	4.06	3.99	3.97
1999	3.31	3.56	3.33	3.40	3.41	3.51	3.40	3.44	3.42
$\overline{x}$ (B×C)	3.60	3.85	3.59		3.68	3.74	3.73		
$\overline{x}$ (B)	3.68				3.72				
$\overline{x}$ (C)	Rockwool – Wełna mineralana (I + II) 3.64			Expanded clay – Keramzyt (I + II) 3.79			Polyurethane foam – Pianka poliuretanowa (I + II) 3.66		
$\overline{x}$	3.69								

Factors: A – years, B – fertilization levels, C – media,
$LSD_{\alpha = 0.05}$ for A = 0.19, $LSD_{\alpha = 0.05}$ for B – n.s., $LSD_{\alpha = 0.05}$ for C – n.s.
$LSD_{\alpha = 0.05}$ for A×B – n.s., $LSD_{\alpha = 0.05}$ for B×C – n.s., $LSD_{\alpha = 0.05}$ for A×B×C – n.s.

Czynniki: A – lata, B – poziomy nawożenia, C – podłoża.
$NIR_{\alpha = 0.05}$ dla A = 0.19, $NIR_{\alpha = 0.05}$ dla B – n.i., $NIR_{\alpha = 0.05}$ dla C – n.i.
$NIR_{\alpha = 0.05}$ dla A×B – n.i., $NIR_{\alpha = 0.05}$ dla B×C – n.i., $NIR_{\alpha = 0.05}$ dla A×B×C – n.i.

Table 2. The effect of fertilization levels and inert media on phosphorus content in the index plant part of greenhouse tomato cv. ‘Maeva F_1’ (% P d.m., mean for terms)

Tabela 2. Wpływ poziomów nawożenia i podłoży inertnych na zawartość fosforu w części wskaźnikowej pomidora szklarniowego odmiany ‘Maeva F_1’ (% P s.m., średnia z terminów)

Years Lata	Level I (B) – Poziom I (B)				Level II (B) – Poziom II (B)				
	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	$\overline{x}$
(A)	(C)	(C)	(C)	(A×B)	(C)	(C)	(C)	(A×B)	(A)
1998	0.47	0.48	0.47	0.47	0.44	0.49	0.46	0.46	0.46
1999	0.36	0.35	0.35	0.35	0.41	0.38	0.36	0.38	0.36
$\overline{x}$ (B×C)	0.41	0.41	0.41		0.42	0.43	0.41		
$\overline{x}$ (B)	0.41				0.42				
$\overline{x}$ (C)	Rockwool – Wełna mineralna (I + II) 0.41			Expanded clay – Keramzyt (I + II) 0.42			Polyurethane foam – Pianka poliuretanowa (I + II) 0.41		
$\overline{x}$	0.41								

Factors: A – years, B – fertilization levels, C – media.
$LSD_{\alpha = 0.05}$ for A = 0.04, $LSD_{\alpha = 0.05}$ for B – n.s., $LSD_{\alpha = 0.05}$ for C = 0.03,
$LSD_{\alpha = 0.05}$ for A×B – n.s., $LSD_{\alpha = 0.05}$ for B×C – n.s., $LSD_{\alpha = 0.05}$ for A×B×C – n.s.

Czynniki: A – lata, B – poziomy nawożenia, C – podłoża.
$NIR_{\alpha = 0.05}$ dla A = 0.04, $NIR_{\alpha = 0.05}$ dla B – n.i., $NIR_{\alpha = 0.05}$ dla C = 0.03,
$NIR_{\alpha = 0.05}$ dla A×B – n.i., $NIR_{\alpha = 0.05}$ dla B×C – n.i., $NIR_{\alpha = 0.05}$ dla A×B×C – n.i.

Table 3. The effect of fertilization levels and inert media on potassium content in the index plant part of greenhouse tomato cv. 'Maeva F_1' (% K d.m., mean for terms)

Tabela 3. Wpływ poziomów nawożenia i podłoży inertnych na zawartość potasu w części wskaźnikowej pomidora szklarniowego odmiany 'Maeva F_1' (% K s.m., średnia z terminów)

Years Lata	Level (B) – Poziom I (B)				Level II (B) – Poziom II (B)				
	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	$\overline{x}$
(A)	(C)	(C)	(C)	(A×B)	(C)	(C)	(C)	(A×B)	(A)
1998	5.02	5.55	5.09	5.22	5.17	5.31	5.16	5.21	5.21
1999	5.54	5.23	4.85	5.21	5.29	5.62	5.85	5.59	5.40
$\overline{x}$ (B×C)	5.28	5.39	4.97		5.23	5.46	5.50		
$\overline{x}$ (B)	5.21				5.40				
$\overline{x}$ (C)	Rockwool – Wełna mineralna (I + II) 5.25			Expanded clay – Keramzyt (I + II) 5.42			Polyurethane foam – Pianka poliuretanowa (I + II) 5.23		
$\overline{x}$	5.30								

Factors: A – years, B – fertilization levels, C – media.
$LSD_{\alpha = 0.05}$ for A – n.s., $LSD_{\alpha = 0.05}$ for B – n.s., $LSD_{\alpha = 0.05}$ for C – n.s.,
$LSD_{\alpha = 0.05}$ for A×B – n.s., $LSD_{\alpha = 0.05}$ for B×C – n.s., $LSD_{\alpha = 0.05}$ for A×B×C – n.s.

Czynniki: A – lata, B – poziomy nawożenia, C – podłoża.
$NIR_{\alpha = 0.05}$ dla A – n.i., $NIR_{\alpha = 0.05}$ dla B – n.i., $NIR_{\alpha = 0.05}$ dla C – n.i.,
$NIR_{\alpha = 0.05}$ dla A×B – n.i., $NIR_{\alpha = 0.05}$ dla B×C – n.i., $NIR_{\alpha = 0.05}$ dla A×B×C – n.i.

Table 4. The effect of fertilization levels and inert media on calcium content in the index plant part of greenhouse tomato cv. 'Maeva F_1' (% Ca d.m., mean for terms)

Tabela 4. Wpływ poziomów nawożenia i podłoży inertnych na zawartość wapnia w części wskaźnikowej pomidora szklarniowego odmiany 'Maeva F_1' (% Ca s.m., średnia z terminów)

Years Lata	Level I (B) – Poziom I (B)				Level II (B) – Poziom II (B)				
	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\bar{x}$	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\bar{x}$	$\bar{x}$
(A)	(C)	(C)	(C)	(A×B)	(C)	(C)	(C)	(A×B)	(A)
1998	7.47	7.95	8.04	7.82	6.50	7.50	7.40	7.13	7.47
1999	7.08	8.12	8.22	7.80	7.40	6.90	7.36	7.22	7.51
$\bar{x}$ (B×C)	7.27	8.03	8.13		6.95	7.20	7.38		
$\bar{x}$ (B)	7.81				7.18				
$\bar{x}$ (C)	Rockwool – Wełna mineralna (I + II) 7.11			Expanded clay – Keramzyt (I + II) 7.61			Polyurethane foam – Pianka poliuretanowa (I + II) 7.75		
$\bar{x}$	7.49								

Factors: A – years, B – fertilization levels, C – media.
$LSD_{\alpha=0.05}$ for A – n.s., $LSD_{\alpha=0.05}$ for B – n.s., $LSD_{\alpha=0.05}$ for C – n.s.,
$LSD_{\alpha=0.05}$ for A×B – n.s., $LSD_{\alpha=0.05}$ for B×C – n.s., $LSD_{\alpha=0.05}$ for A×B×C – n.s.
Czynniki: A – lata, B – poziomy nawożenia, C – podłoża.
$NIR_{\alpha=0.05}$ dla A – n.i., $NIR_{\alpha=0.05}$ dla B – n.i., $NIR_{\alpha=0.05}$ dla C – n.i.,
$NIR_{\alpha=0.05}$ dla A×B – n.i., $NIR_{\alpha=0.05}$ dla B×C – n.i., $NIR_{\alpha=0.05}$ dla A×B×C – n.i.

Table 5. The effect of fertilization levels and inert media on magnesium content in the index plant part of greenhouse tomato cv. 'Maeva F_1' (% Mg d.m., mean for terms)

Tabela 5. Wpływ poziomów nawożenia i podłoży inertnych na zawartość magnezu w części wskaźnikowej pomidora szklarniowego odmiany 'Maeva F_1' (% Mg s.m., średnia z terminów)

Years Lata	Level I (B) – Poziom I (B)				Level II (B) – Poziom II (B)				
	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	Rockwool Wełna mineralna	Expanded clay Keramzyt	Polyurethane foam Pianka poliuretanowa	$\overline{x}$	$\overline{x}$
(A)	(C)	(C)	(C)	(A×B)	(C)	(C)	(C)	(A×B)	(A)
1998	0.69	0.71	0.74	0.71	0.65	0.64	0.62	0.63	0.67
1999	0.45	0.43	0.45	0.44	0.47	0.38	0.40	0.42	0.43
$\overline{x}$ (B×)	0.57	0.57	0.59		0.56	0.51	0.51		
$\overline{x}$ (B)	0.57				0.53				
$\overline{x}$ (C)	Rockwool – Wełna mineralna (I + II) 0.56			Expanded clay – Keramzyt (I + II) 0.54			Polyurethane foam – Pianka poliuretanowa (I + II) 0.55		
$\overline{x}$	0.55								

Factors: A – years, B – fertilization levels, C – media.
$LSD_{\alpha = 0.05}$ for A = 0.06, $LSD_{\alpha = 0.05}$ for B – n.s., $LSD_{\alpha = 0.05}$ for C – n.s.,
$LSD_{\alpha = 0.05}$ for A×B – n.s., $LSD_{\alpha = 0.05}$ for B×C – n.s., $LSD_{\alpha = 0.05}$ for A×B×C – n.s.

Czynniki: A – lata, B – poziomy nawożenia, C – podłoża.
$NIR_{\alpha = 0.05}$ dla A = 0.06, $NIR_{\alpha = 0.05}$ dla B – n.i., $NIR_{\alpha = 0.05}$ dla C – n.i.,
$NIR_{\alpha = 0.05}$ dla A×B – n.i., $NIR_{\alpha = 0.05}$ dla B×C – n.i., $NIR_{\alpha = 0.05}$ dla A×B×C – n.i.

CONCLUSIONS

1. No significant effect of rockwool, expanded clay and polyurethane foam used as root media on nitrogen, potassium, calcium and magnesium content in the index parts (9–10 leaf from the top) of greenhouse tomato cv. 'Maeva F_1' was found. An exception was phosphorus whose content was significantly higher in the leaves of the plants grown in expanded clay.

2. Increasing component content in feeding solution by 20% in relation to standard one did not have significant effect on nutrient contents in the index parts of the greenhouse tomato cv. 'Maeva F_1'.

3. Mean content of macronutrients in the index parts (8–9 leaf from the top) of the greenhouse tomato cv. 'Maeva F_1' was (% in d.m.): N – 3.69, P – 0.41, K – 5.30, Ca – 7.49 and Mg – 0.55.

4. High calcium content in the feeding solutions (190–230 mg Ca dm^{-3}) due to high content of this component in the water used for fertigation, was confirmed by high nutrition status. Calcium content in the index parts of the cv. 'Maeva F_1' plants was on average 7.49% Ca of d.m. and exceeded mean potassium content.

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STAN ODŻYWIENIA POMIDORA SZKLARNIOWEGO UPRAWIANEGO W PODŁOŻACH INERTNYCH. Cz. I. MAKROELEMENTY

Streszczenie. W doświadczeniach badano wpływ podłoży inertnych oraz poziomów nawożenia na stan odżywienia pomidora szklarniowego odmiany 'Maeva F_1'. Zastosowano dwie pożywki o składzie (w $mg \cdot dm^{-3}$): pożywka I: $N\text{-}NO_3$ – 189, P – 62, K – 371, Ca – 190, Mg – 49, Fe – 0,84, Mn – 1,87, B – 0,32, Zn – 2,01, Cu – 0,048, Mo – 0,048, pH 5,5, EC – 3,2 $mS \cdot cm^{-1}$, i pożywka II z zawartością składników zwiększoną o 20%. Ponadto badano trzy podłoża inertne: wełnę mineralną (Grodan), piankę poliuretanową (Inert) i keramzyt (granulacja 4–8 mm). W częściach wskaźnikowych pomidora (9–10 liść od wierzchołka) średnia zawartość składników pokarmowych wynosiła (w s.m.): N – 3,69%, P – 0,41%, K – 5,30%, Ca – 7,49%, Mg – 0,55%. Nie stwierdzono istotnego wpływu wełny mineralnej, keramzytu i pianki poliuretanowej na zawartość azotu, potasu, wapnia i magnezu w częściach wskaźnikowych pomidora szklarniowego. Wyjątek stanowił fosfor, którego zawartość była wyższa w roślinach uprawianych w keramzycie. Poziomy nawożenia nie wpływały w istotnym stopniu na zawartość makroskładników w częściach wskaźnikowych.

Słowa kluczowe: podłoża inertne, uprawy bezglebowe, fertygacja, pomidor

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