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PRELIMINARY STUDIES REGARDING THE IMPROVEMENT OF TOMATO QUALITY THROUGH TECHNOLOGICAL MEASURES

STUDII PRELIMINARE PRIVIND ÎMBUNĂTĂȚIREA CALITĂȚII FRUCTELOR DE TOMATE PRIN DIFERITE MĂSURI TEHNOLOGICE

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Abstract. *The tomatoes represent the most largely spread vegetable species, being valued across all continents and cultivated over the period of the entire year. The tomato nutritional quality largely depends on the genetic potential of the cultivar, the biotope, as well as the fertilization system that was used. The main aim of these studies represents the analysis of the effect of using different technological means (cultivar, fertilization, irrigation) in order to obtain the tomato fruits with a high nutritional content.*
Key words: tomato, quality, fertilizers, irrigation regime

Rezumat. *Tomatele reprezintă specia legumicolă cu cea mai largă răspândire dintre toate speciile legumicole, fiind apreciată pe toate continentele şi pe durata întregului an. Calitatea nutritivă a fructelor de tomate depinde în mare masură de potențialul genetic al cultivarului, de biotop dar şi de sistemul de fertilizare utilizat. Scopul principal al acestor studii îl reprezintă analiza efectului utilizării diferitelor mijloace tehnologice (cultivar, fertilizare, irigare) în vederea obținerii fructelor de tomate cu conținut ridicat în principii nutritive.*
Cuvinte cheie: tomate, calitate nutritiva, fertilizanti, regim irigare

INTRODUCTION

In Romania, tomatoes occupy the highest share of vegetable cultures, growing annually on about 60,000 hectares, approximately 20-25% of the vegetable area in the open field, and 60-80% of that in protected crops by some authors. The efficiency of crop production can be achieved by: mechanized planting of seedlings, the use of cultivation of high productivity and resistance to diseases, obtaining the earliest harvests by using fructification biostimulators, harnessing production with the highest prices obtained as a result of the earliest occurrence of its production and superior quality (Munteanu, 2003; Indrea *et al.,* 2007; Dumitrescu *et al.,* 1998; Voican and Lacatus, 1998).

MATERIAL AND METHODS

The preliminary studies and researches were carried out on the basis of documentary and bibliography study from international and national literature, aimed

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at: choosing the assortment of tomatoes for protected area, studies and research on the use of fertilization and irrigation regim and studies on nutritional value and antioxidant activity of tomatoes.

RESULTS AND DISCUSSION

Studies and research on the use of fertilization regim

The tomato crop in the tunnel uses very intensive soil resources. For a production of 12 kg/m^2, tomato fruits hold a weight of 74.3% of the fresh mass, 51.1% of N assimilated, 60.9 of K, 53% of P, 31.1% of Ca and 23.4% of Mg. assimilated by the plant. At the same time, at a production of 12 kg fruit/plant and at a fresh table of 19.1% kg/m^2, tomatoes, extract from soil 158,7 g/m^2 mineral substances of which: 39 g N/m^2, 69 g K/m^2, 4.8 g P/m^2, 45g Ca/m^2 and 5.9 g Mg/m^2.

Instead, at a production of 6 kg/m^2, corresponds to a fresh mass of 9.4% kg/m^2, and the sampling of mineral elements amounts to 80.6 g/m^2, mineral substances of which: 19g N/m^2, 30g K/m^2, 2.8 g P/m^2, 25gCa/m^2 and 3.8 g Mg/m^2 (Voican and Lăcătuş, 1998).

In conclusion, we can say that toamatele have a specific consumption per tonne of product, which is in close correlation with the irrigation factor, the stage of development, the system of culture practiced and the biological production (tab. 1).

Table 1

The need for NPK in protected area for tomatoes crop during the vegetation period (by various authors)

Stage development	Ration N:P:K	
	Tomatoes in greenhouse	Tomatoes in tunnel
Planting	1: 0.4 – 0.7 : 2.1 – 3.6	1: 0.6 – 1.0 : 1.8 – 2.8
Opening Inflorescence I	1: 0.4 – 0.6 : 2.0 – 3.0	1: 0.5 – 0.7 : 1.6 – 2.5
Opening Inflorescence III	1: 0.3 – 0.6 : 1.8 – 2.5	1: 0.4 – 0.6 : 1.4 – 2.0
Fruit growth	1: 0.3 – 0.5 : 1.7 – 2.0	1: 0.2 – 0.4 : 1.2 – 1.8
Starting the harvest	1: 0.2 – 0.3 : 1.5 – 1.8	1: 0.2 – 0.4 : 1.4 – 2.0
Intense harvesting	1: 0.1 – 0.2 : 1.8 – 2.0	1: 0.1 – 0.2 : 1.6 – 2.2
Decline of culture	1: 0.2 – 0.3 : 1.5 – 1.8	1: 0.2 – 0.4 : 1.2 – 1.5

Ghidia *et al.,* 1980, quoted by Popescu and Popescu (2003) mentions the complexity of the nutrition regime, specifying that it is taken into account in the case of tomatoes of specific consumption which differ according to: cultivation, vegetation phase, culture system and planned production etc. (tab. 2).

According to the ecological directives, the surface of the tunnel can be fertilized with a quantity of maximum 170 kg N a.s./ha/year (Stoleru *et al.,* 2013).

The production of tomatoes cultivated in organic solar systems can be between 7 and 20 kg per m^2 depending on the system and climate. The quantity of fertilizers shall be oriented according to the value of production and the subsequent delivery capacity of the nutrients in the soil.

Table 2

Specific consumption of elements on tomato crops in greenhouses and solariums
(by Ghidia *et al.,* 1980, quoted in Popescu, 2003)

Crop system	Evaluated production (kg/m^2)	Specific consumption (g/m^2)				
		N	P	K	Cu	Mg
Greenhouse – cicle	8-10	3.09	0.64	3.36	2.19	0.63
Greenhouse – cicle II	5-7	4.00	0.39	5.23	3.30	0.48
Tunnel	5-7	5.00	0.47	5.73	4.16	0.63

Studies on the nutritional value of tomatoes and their antioxidant activity

Studies on nutritional value and antioxidant activity in tomatoes has been analyzed along the type of many authors (Guil-Guerreroa *et al.,* 2007, Butnariu si Butu, 2014; Munteanu, 2003). Research conducted in Almeria (Spain), on eight cultivation of tomatoes cultivated in the greenhouse (Cherry, Cherry Pera, Daniela near Vida, Lido, Pera, Racimo, Raf, Rambo) showed that the composition of the analyzed tomatoes is similar, in qualitative terms, with the results Existing in the literature (Raffo *et al.,* 2002), with small differences, namely: higher amounts of vitamin C and carotenoids in these varieties of tomatoes than in conventional varieties, the presence or absence of certain carotenoids. All the varieties present in this study showed high amounts of nitrates ranging from 108 mg to and 470 mg in Cherry Rambo and in Racimo (mg/100g fresh weight).

The vitamin C content of the studied cultivation is higher than those mentioned in the literature: Rambo-263 mg, Racimo – 174 mg, Pera – 164 mg, reported at 100 g fresh product. Chang *et al*., 1977 reported 21 mg/100 g fresh product.

Raffo *et al*. (2002) indicates a low amount of ascorbic acid for cherry tomatoes during maturation, with an average of 12 mg/100 g fresh weight.The values of the micro-elements recorded variations being likely influenced by agronomic practices (artificial substrate).

The following fatty compounds were found in tomatoes: linoleic acid, palmitic acid and oleic acid. Linoleic acid ranged between 61.8% of the total Cherry fatty acids, 61.0% Racimo and 60.4% in the Lido.

In addition to lycopene, tomatoes and tomato products we also meet other carotenoids such as: Violaxantină, Neoxantină, lutein, Zeaxanthin, A-Cryptoxanthin, B-Cryptoxanthin, A-carotene, B-carotene, G-carotene, Z-carotene, neurosporene, Fitoenă, Fitofluenă, Ciclolopen. The oxalic acid content varies between the value of 9.9 for the Daniela Larga Vida variety and 39.0 for the Pera variety (mg/100g fresh product); From a nutritional point of view, the main problem with oxalic acid is its ability to diminish the bioavailability of calcium phytochemical representative preparations identified in tomatoes are Fitoena, Fitofluena, B-carotene, flavonoids, carotenoids, Lycopene, quercetin, polyphenols and kaempferol. Green, unripe leaves, stems and fruits of the tomato plant contain small amounts of toxic alkaloids such as Tomatina and Solanine (Butnariu and Butu, 2014).

Table 3

Chemical and biochemical composition of certain varieties of tomatoes (by Guil-Guerreroa et al., 2009)

Cultivar	Humidity %	Protein (g)	Carbohy-drates (g)	Lipids (g)	Fibre (g)	Ash (g)	Energy (kcal)	C Vitamine (mg)	Saponifica-bil oil (g/100g dw)	β-caroten	Lycopen	Oxalic acid	Nitrates
Cherry	95.2±0.8	0.78±0.02	1.27±0.5	0.49±0.05	1.13±0.11	0.90±0.10	12.3±1.3	82±20	9.06±0.17	73±8	360±34	22.4±2.9	470±69
Cherry Pera	92.6±1.3	1.05±0.06	2.18±0.29	0.42±0.06	1.60±0.11	1.41±0.09	16.2±2.3	39±12	3.35±0.13	48±5	28±4	14.6±1.8	215±48
Daniela Larga Vida	96.0±1.0	0.8±0.02	1.26±0.32	0.28±0.06	0.74±0.10	0.75±0.14	10.4±1.8	62±12	5.51±0.20	20±4	129±11	9.9±1.32	154±33
Lido	94.7±0.8	0.75±0.08	1.56±0.23	0.67±0.04	1.10±0.09	1.00±0.11	14.9±2.0	130±25	11.5±0.20	5±2	291±26	14.7±2.8	329±83
Pera	96.0±1.4	0.56±0.03	1.16±0.09	0.26±0.04	0.78±0.15	0.78±0.13	8.9±1.6	164±22	3.89±0.19	4±1	234±24	39.0±1.9	352±41
Racimo	93.3±1.4	0.91±0.07	1.91±0.44	0.20±0.04	1.25±1.14	1.25±0.16	12.6±1.7	174±21	2.60±0.14	15±3	397±43	19.3±2.3	108±119
Raf	93.9±1.5	0.96±0.07	2.04±0.68	0.47±0.06	1.27±0.11	1.14±0.14	15.7±1.9	155±0.10	6.72±0.14	28±4	97±11	18.7±2.6	459±71
Rambo	95.8±0.8	0.55±0.08	1.01±0.61	0.44±0.03	0.99±0.12	0.82±0.18	9.9±1.0	263±22	7.49±0.12	56±7	120±12	11.4±3.0	108±91

Table 4

Content in macro and microelements in some cultivars analyzed by tomatoes (by various authors)

Cultivars	Na	K	Ca	Mg	P	S	Mn	Fe	Cu	Zn
	mg/100g fresh product									
Cherry	4.0±0.4	301±16	15.9±0.6	22.4±1.9	17.5±2.8	28.6±0.4	253±6	1539±18	265±5	351±54
Cherry Pera	4.9±0.1	249±17	11.6±1.2	13.9±1.3	27.3±3.1	33.6±0.3	197±11	2015±62	317±4	631±42
Daniela Larga Vida	7.3±0.3	290±12	13.1±1.5	14.1±0.9	9.9±3.6	16.7±0.6	135±12	2092±23	45±8	1730±62
Lido	5.8±0.5	278±14	20.1±0.8	18.5±1.4	24.7±2.9	30.5±0.5	306±10	1684±23	232±8	4520±31
Pera	5.9±0.2	253±14	16.3±0.7	10.8±0.8	12.4±2.8	21.3±0.4	190±10	3513±25	392±8	1104±35
Racimo	4.0±0.4	319±16	10.8±0.6	14.9±1.4	24.4±2.0	27.0±1.0	129±6	587±24	91±3	357±25
Raf	17.4±0.5	299±21	17.8±0.8	17.8±1.1	23.4±1.8	36.8±0.4	66±11	488±47	56±5	155±30
Rambo	4.1±0.6	286±13	14.7±1.2	19.7±1.4	7.8±0.7	25.1±0.8	144±17	1445±43	110±7	5479±24

Red tomatoes are the richest sources of lycopene, and the yellow ones in carotene; Lycopene and carotene annihilate free radicals and prevent the formation of carcinogenic metabolism (Butnariu, 2014).

Lycopene and carotene, are provitamins A, which do not degrade by boiling preserved tomato juices, prepared without preservatives, are effective in the vitaminizarea of the human body during the winter period.The quantity and quality of tomato fruits is much influenced by the irrigation regime.

Under the same conditions of fertilization, a higher content of lycopene and vitamin C resulted from the decrease of irrigation levels – better results were achieved with a 206 mm/year irrigation regimen and a fertilization regimen between 255 and 382.5 kg/ha a.s. NPK. The fruit ity has been improved by high levels of fertilizer and a low amount of water used for irrigation).

Table 5

Results of the application of various fertigation treatmentson tomatoes (byWang *et al.,* 2015)

Treatments	Yield (10^3 kg/ha)	Water use efficiency (kg/m^3)	Potential for fertilizers (kg/kg)	Solubile substances (%)	Lycopen (mg/kg)	C Vitamin (mg/100g)	Nitrates (mg/kg)
$W_1 F_1$	95.8	34.5	187.9	4.94	33.41	25.07	51.73
$W_1 F_2$	89.9	32.2	235.1	4.86	27.20	22.47	47.43
$W_1 F_3$	78.0	27.6	305.8	4.67	20.43	20.16	37.94
$W_2 F_1$	85.7	37.0	168.0	5.01	45.68	30.45	56.11
$W_2 F_2$	83.0	36.1	217.0	4.87	38.44	28.48	47.15
$W_2 F_3$	76.2	33.2	299.0	4.81	27.14	26.16	40.27
$W_3 F_1$	78.0	45.3	153.0	5.01	54.28	40.31	64.35
$W_3 F_2$	75.9	44.9	198.5	4.92	46.43	36.11	57.08
$W_3 F_3$	71.2	41.7	279.2	4.84	34.93	32.28	45.75

From the quantitative point of view the highest productions were achieved in the situation of using rules of 262 mm/year and a fertilization regimen of 510 kg/ha a.s. NPK.

In conclusion, proper application of treatment (W2F1) can be a good solution for tomatoes cultivated in the studied area.

CONCLUSIONS

The production and quality of tomato fruits is close correlation with the irrigation factor, the stage of development, the system of culture practiced and the biological production

The irrigation of tomatoes shall be carried out whenever necessary so that the moisture in the soil is 50-60%, from planting up to the appearance of fruit and 60-70%, during the fruit setting period. The irrigation rule for the short cycle is approx. 4000 m^3/ha, distributed in 10-12 times and approx. 6000 m^3/ha, in the long cycle, distributed in 15-20 times.

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