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THE EFFECT OF ORGANIC FERTILIZATION ON FRUIT PRODUCTION AND QUALITY OF TOMATOES GROWN IN THE SOLAR

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ABSTRACT

The purpose of this study was to observe the effect of organic fertilization on the production and quality of tomato fruits grown in early culture in the solar. The influence of this fertilizer was followed in 2017 in a tomato crop in southwestern Romania (Almăj-Dolj). The Reyana hybrid was studied which was foliarly fertilized with the organic product Folicist in the doses of 0.5 l/ha, 1.0 l/ha and 1.5 l/ha. The parameters traced were: production, humidity, soluble dry substance, titratable acidity, vitamin C content, total polyphenols and carotenes as well as fruit pH. The highest yield of 12.76 t/ha was obtained at a dose of 1.0 l/ha and also at the same dose were recorded the best quality parameters of the fruit, such as: S.D.S. was 4.7 °Bx, humidity of 90.3%, titre acidity of 1.33 mg/NaOH/100g f.m., vitamin C of 24.3 mg/100g f.m., total polyphenols 66.4 mg/100g f.m., total carotenes 51.3 mg/100g f.m. and pH 4.49.

These results show that an adequate fertilization of plants with nutrients substances is crucial to achieving high yields and good-tasting fruits.

INTRODUCTION

The intensive use of chemical fertilizers in agriculture has caused many unrecoverable consumer health problems and environmental pollution. In order to reduce and eliminate the adverse effects of the use of synthetic fertilizers and pesticides on human health and environment, new agricultural practices have been developed in so-called organic agriculture or sustainable agriculture (Chowdhury, 2004; Popescu and Căpruciu, 2016).

Organic fertilizers take the place of the chemical. The main sources of organic fertilizer are: animal fertilizer compost, plant waste and industrial waste. All these provide the crop plants with the nutrients they need in sufficient quantities and in easily assimilable forms. In addition, they increase microbial soil activity (Popa et al., 2010), the anion and cation exchange capacity of organic matter (Becherescu et al., 2016) as well as the content of carbon in the soil (Liu et al., 2007; Tonfack et al., 2009).

Tomatoes are one of the most important vegetable species cultivated in Romania, registering over 620 thousand tonnes in 2016 (http://www.madr.ro/horticultura). This production is mainly achieved in a conventional system, both in the field and in protected areas (Soare Rodica and Duta Adriana, 2008). Organic farming has begun to increase the interest among farmers, thus more organic fertilizers appear on the Romanian market. There are certain products that have been certificatied for organic farming, but there are also products that are not certified.

This study aimed at observing the effect of Folicist, organic product, on the production and quality of tomato cultivated in the solar as well as setting the optimal dose for fertilization.

MATERIAL AND METHOD

PLANT MATERIAL

In a heated solar under the pedoclimatic conditions in south-western Romania (Almăj-Dolj) a tomato crop was set up. The hybrid Reyana, which was planted on February 28, 2017, was taken into consideration planted after the following technological scheme: 50 + 100 (9) + 50 x 35 cm. The experience was placed in randomized blocks, with three repetitions. It was applied the organic tomato technology in the solar, paying attention to the control of diseases and pests through specific preventive treatments with products certified for organic farming. Four foliar fertilizations with the Folicist organic product were carried out according to the following variants: V1 - unfertilized control; V2 -fertilized with 0.5 l/ha; V3-fertilized with 1.0 l/ha and V4 - fertilized with 1.5 l/ha at 10 days between treatments. The first treatment was 2 weeks after planting. Plants were harvested after 4 inflorescences.

In the basic fertilization, compost from vegetable residue from a tomato crop was applied. By using this product, recirculation of the fertilizers used by the previous tomato crop is ensured and is in a form easily accessible to plants of the same species, namely tomatoes.

Sample preparation

Ten fruits were harvested from each experimental variation, which were taken to the laboratory where they were washed, they were wiped with paper towels and cut to remove the seeds. The pericarp and mesocarp were placed in a blender for 1 minute, resulting in a homogeneous purée. The experiments were performed in three repetitions, and the results were expressed as the mean of repetitions.

Humidity

A gravimetric assay was performed to evaluate the physiological tomato weight loss that was calculated by the difference between initial and final weight. A porcelain capsule containing 5g of fresh tomato was placed in a stove (Memmet) at 105ºC ± 1ºC, followed by regular weighing up to a constant weight. Results were expressed in water percentage (%).

The soluble dry substance content was determined using an Optical Digital Handheld Refractometer Dr301-95 set at $t=20^{0}C$.

The determination of titratable acidity.

From a sample of 5-10 g of tomatoes homogenated with a vertical blender Braun MR 404 Plus for 1 minute, 1-2 ml were taken which were diluted in 10 ml of distilled water and titrated with 0.1 N sodium hydroxide in the presence of phenolphthalein.

The acidity calculation is made using the formula:

$$AT,(\%) = \frac{V\,x\,N}{m} x100$$

V - volume of NaOH solution used for titration, (ml); **m** - sample weight, (grame); **N** - normality of NaOH solution

pH values were measured in triplicate with a pH-meter.

The determination of vitamin C content

A sample of 5-10 g of tomatoes, previously ground with quartz sand has been put into a 100 ml- balloon by using a solution of 2% hydrochloric acid. It has been stirred and after sedimenting it has been filtered into a dry glass. A 10-ml aliquot has been passed into a Berzelius glass, to which 30 ml of distilled water; 5 ml of 1% potassium iodate and 1 ml solution of starch have been added. It has been then titrated with potassium iodate N/250 stirred until becoming bluish (2).

The calculation of ascorbic acid concentration is made by using the equation:

Vitamin C mg % = 352. n.f / G, Where:

n - ml used for titration; f – the factor of the potassium iodate N/250;

G – the sample weight in grams.

The total phenol in tomato fruit was estimated by the method proposed by Mallick and Singh (1980) and total phenol content was expressed as mg tannic acid100 g^{-1} fresh wt of tomato.

The determination of total carotenoids

The weighed samples, having been put separately in 95% in acetone (50 ml for each gram), were homogenized with Braun MR 404 Plus for one minute. The homogenate was filtered and was centrifuged using the Hettich Universal 320/320R centrifuge at 2500 rpm for ten minutes. The supernatant was separated and the absorbances were read at 400-700nm on Cary 50 spectrophotometer.

Statistical Calculation

The data recorded were statistically processed by using the analysis of the variant (ANOVA) and the calculation of the limit differences, LSD 0.05%.

RESULTS AND DISCUSSIONS

Vegetable species cultivated in the solar offer advantages compared to those cultivated in the open field with regard to quality assurance, mainly because plants are not directly exposed to rapid climate changes. Tomato fruits contain a high level of antioxidants such as vitamin C, polyphenols, carotenoids, etc. Some studies have shown a higher level of bioactive compounds in organically produced tomatoes compared to those obtained in conventional method, but not all studies have been conclusive in this regard. Levels of bioactive compounds are very variable and can be affected by the cultivar, crop system, harvesting and storage maturity.

In this study, the production and quality of tomato fruit was evaluated, determining: the production per m^2 and per plant, humidity, soluble dry substance, pH (Table 1), titratable acidity, vitamin C, total polyphenol content and total carotene (table 2).The water content and the S.D.S are components that determin the taste of the fruit, since a higher content of dry matter and a lower water content influence especially the content of sugars and acids (Dinu et al., 2015).

For experimental variants the percentage of water ranged from 93.7% at V2 to 90.3% at V3 (Table 2) correlating with the S.D.S content which had the highest value in the fertilized variant with a dose of 1, 0 l/ha of Folicist, the lowest value being at the control variant, the non-fertilized one. It is noted that V3 with 4.75 ^{0}Bx S.D.S, although it did not have the highest dose of organic fertilizer had the highest content in this constituent.

Sima et al., (2010), in an experimental study on tomatoes, single and double fertilization doses have found that doubling the fertilizer dose increases the content in S.D.S.

Table 1

The parameters of quality and production of tomato, Reyana hybrid

Var.	Humidity (%)	S.D.S (°Bx)	pH	Production (kg/plant)	Production (kg/m²)
V1-control	93.2a	4.10b	4.50ns	3,84b	10,75b
V2	93.7a	4.69a	4.53ns	4,08a	11,42ab
V3	90.3b	4.75a	4.49ns	4,56a	12,76a
V4	91.4ab	4.72a	4.45ns	4,32ab	12,10a
LSD 0.05	2.74	0.44	0.39	0.52	1.80

ns – no significant for $p \leq 0.05$, Values in the same column followed by different superscript letters are significantly different

The pH varied from 4.45 at V4 (fertilized with 1.5 l/ha of Folicist) to 4.53 at V2 (the variant with lowest fertilization dose - 0.5 l/ha), thus observing a rather small variation between variants.

The production of tomato fruit can be influenced by the cultivar, the method of grafting, growing conditions and by the number of stems/plant 1 or 2 stems (Hoza, 2013. The **fruit production** obtained per plant and per m^2 recorded increases in all fertilized variants compared to the unfertilized control variant. Production per plant had values ranging from 3.84 kg at V1 and 4.56 kg at V3. All fertilized variants had superior values compared to those of the unfertilized witness.

Regarding the production per m^2, although the growth of the plants was limited to 4 inflorescences, it can be noticed that V3 with a fertilization dose of 1L/ha of Folicist recorded the highest production of 12.76 kg/m^2. For this parameter it can be said that the fertilization dose has influenced the production because also at V4 there were obtained 12.10 kg/m^2, followed by V2 and finally V1 unfertilized with 10.75 kg/m^2. The results of this study are also supported by Tonfack et al., (2008), which, in a study of 2 tomato cultivars with determined growth, found increases in production at the variant fertilized with manure and organo-mineral fertilizer compared to unfertilized variant.

The titratable acidity was expressed in mg NaOH/100g and varied in the four experimental variants depending on the fertilization dose. The highest values were recorded in variants 3 and 4 which had the highest fertilization dose, but there were no significant differences between variants (Table 2). In the organic culture system, titrable acidity values are increased compared to conventional culture (Pieper JR and Barrett DM, 2009).

Thybo et al., (2006) after a study conducted on a tomato crop in greenhouse, cultivated in organic system, says that the crop system, especially the organic one, positively influences the quality of tomato fruits. The effect of the culture system on titratable acidity may actually be an important factor in the physiological maturity of the fruit.

Tomato fruits are also rich in antioxidant compounds that are recognized as being useful for human health. Among these, vitamin C is a health promotion factor with antioxidant properties. Although the content of tomato antioxidants may depend on genetic factors for a given variety, it may vary depending on the culture system, the fertilization doses (Dinu et al., 2015) or may be influenced by the K supply (Sima et al., 2010). Higher vitamin C content was recorded at V3 with 24.3 mg/100g f.m and the lowest at V1 with 15.2 mg/100g f.m. These values are also supported by Duma et al., (2015), Oliveira et al., (2013) and Sima et al., (2010). Considering that tomatoes have been planted on a fertilized soil with organic fertilizers, this substrate being warmer than a normal soil, this causes an increase in the root system temperature that causes an increase in the concentration of biochemical components in tomato fruit.

Table 2

Biochemical parameters of tomato fruits

Var.	Acidity (mg/NaOH/100 g f.m.)	Vit. C (mg/100g f.m.)	Polyphenols (mg/100g f.m.)	Carotene (mg/100g f.m.)
V1-control	1.23ns	15.2d	24.3b	32.5d
V2	1.29ns	22.6b	64.1a	43.5c
V3	1.33ns	24.3a	66.4a	51.3a
V4	1.31ns	21.2c	60.0a	48.7b
LSD 0.05	0.13	1.39	7.22	1.66

ns – no significant for $p \leq 0.05$, Values in the same column followed by different superscript letters are significantly different

The total content of polyphenols in tomato fruits was measured at physiological maturity. A significantly higher amount of polyphenols (66.4 mg/100g f.m.) was recorded in the fruit harvested from V3 fertilized with Folicist 1l/h in comparison with V1 un fertilised.

The total carotene content may be influenced by the fruit maturity phase, genotype, and culture system. The results of our study revealed an increase in carotene content in all fertilized variants with the Folicist organic product. The values of this indicator ranged from 32.5 mg/100g f.m at V1 to 51.3 mg/100g f.m at V3 significant difference between fertilized and unfertilized variant. Table 2 shows that also at this constituent fertilization has also positively influenced the accumulation of fruit.

The values of this study are supported by Zoran et al., (2014) which has the highest content in fruit carotenoids in a cultivated organic tomato crop. Similar results were obtained by Duma et al.,2015. Organic tomatoes have a higher content in carotenoids compared to conventional crops, fact noted as well by Kapoulas et al., 2011, in a comparative study between the organic and conventional systems, being recorded a greater carotenoid content in the organic system.

The quality of tomatoes can be defined as a sum of the requirements a consumer has in order to be satisfied. In addition to the nutraceutical properties of the fruit, it is also possible to include the methods of cultivation (ecological or conventional), the crop system (protected field or protected areas), the cultivar, the methods of keeping the production, etc.

CONCLUSION

In conclusion, this paper showed that the tomatoes cultivated in ecological system and fertilized in vegetation with the Folicist organic product had a good quantitative and qualitative yield. It is very important to find the optimal fertilization dose as well as the appropriate combinations of fertilizers. Basic fertilization with organic fertilizers and foliar application of the Folicist product at a dose of 1l/ha can be recommended for organic production of early tomato crops.

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