RESEARCH ON THE INFLUENCE OF FERTILIZATION AND IRRIGATION METHOD OF TOMATOES OVER THE PRODUCTION

CERCETĂRI PRIVIND INFLUENȚA METODEI DE FERTILIZARE ŞI IRIGARE A CULTURII DE TOMATE ASUPRA PRODUCȚIEI

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Abstract. *The research of this study was carried out at the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad" in Iasi. The experience was set up in a semicircular solar cell where the fertilization regime was pursued: fertilization by irrigation water, fertilization with classical fertilizers, fertilization with microorganisms and non-fertilized. The irrigation was dripped. The tomato production showed a difference from the control of 52.43 t/ha, in the fertilized variant, being considered positively very significant. In the case of tomatoes it was found that the fertilization is clearly superior to the other methods used.*

Key words: fertilization, irrigation, tomatoes, production

Rezumat *Cercetările acestui studiu s-au efectuat în cadrul Universității de Ştiințe Agricole şi Medicină Veterinară "Ion Ionescu de la Brad" din Iaşi. Experiența s-a înființat într-un solar de tip semicircular unde s-a urmărit regimul de fertilizare: fertilizare prin apa de irigare, fertilizare cu îngrăşăminte clasice, fertilizare cu microorganisme şi nefertilizat. Irigarea s-a făcut prin picurare. Producția de tomate a înregistrat o diferență față de martor de 52,43 t/ha, la varianta fertirigată, fiind considerată pozitiv foarte semnificativă. În cazul tomatelor s-a constatat că fertirigația este net superioară celorlalte metode utilizate.*

Cuvinte cheie: fertilizare, irigare, tomate, producție.

INTRODUCTION

Modern farming technologies are based on the long-term soil fertility, resilience and regeneration capacity. Forming, maintaining and preserving soil fertility is the greatest challenge for today's agriculture. From modern and sustainable agricultural technologies, drip irrigation has the highest efficacy, of 90%, compared to conventional irrigation methods; the main benefits of water being absorbed by the soil, creating immediate availability for plants, leakage or evaporation (Drăgănescu, 1986). Being a localized method, water is only given to those areas of the field that require irrigation (plant roots). This paper aims to deal

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with some aspects of research on the influence of the fertilization and irrigation method of tomato culture in protected space on production.

MATERIAL AND METHOD

The experimental researches on the influence of the fertilization method of a tomato crop were carried out in the year 2017 at the "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine in Iasi, Department of Agricultural Mechanization and Vegetable Sector of Horticultural Farm No.3 "Vasile Adamachi"of the Didactic Resort in Iasi. The experiments were carried out in a semi-circular solar tunnel, 25 m long and 5.4 m wide. In order to investigate the influence of the watering method, a drip irrigation and fertilization plant was designed and realized within the department of the Mechanization of Agriculture. The installation was made up of fertilizer tank, automatic watering programming system and water distribution system (Corduneanu *et al.,* 2015) (fig.1).

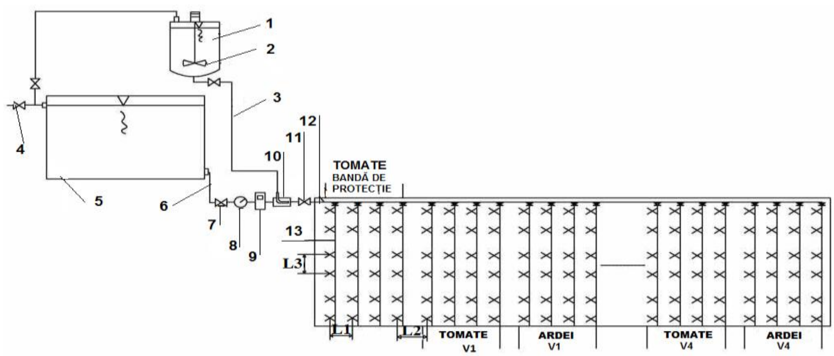

Fig. 1 Scheme of drip irrigation and fertilization:
1- water buffer tank; 2- tank for the preparation of the watering fertilizer solution; 3- agitator; 4 - connection for the buffer tank water supply; 5 - connection for supplying the fertilizer solution; 6 - supply pipe for irrigation facility; 7:11 - valves; 8 - watermeter; 9 - programmer; 10 - ejector for mixing the water-fertilizer solution; 12 - main pipe; 13 - dropping pipeline; L1 - spacing between rows on tape; L2 - distance between tapes; L3 - distance between plants in a row.

The tank used in the experimental fertilization plant had a capacity of 300 L, made of metal, resistant both to mechanical and chemical shocks. On the outside, the tank was graduated from 10 to 10 L, the reading was done using a side-mounted transparent hose, operating on the principle of capillarity. At the top, the reservoir is provided with a feeding mouth through which water is added to mix the water with fertilizers.

Solution mixing was carried out by an electric motor propeller shaker. At the bottom is the outlet of the solution, provided with an opening valve and an outlet hose. The fertilizer solution passes through a 1/2 "hose into the waterline line. The water distribution system was made up of main pipelines, secondary water distribution pipelines and watering equipment. the water made of polyethylene, 1" and 55 m in length, had the link with a secondary water distribution pipeline located in the solar waterworks component. The main pipeline has been connected by a fitting assembly and accessory to a water tank feeding the system.

The secondary water distribution pipeline was placed perpendicular to the rows of plants and had the role of feeding the watering strips representing the active part of the drip irrigation system. Watering equipment (watering line) is the end of the plant, consisting of transport and watering pipes provided with plant water distribution devices. The connection between the water pipe and the drip tap was made by means of valves that can also be used as start connectors. The distance between the orifices on the watering band used in the experiment was 10 cm, their diameter 16 mm and the wall thickness of 0.15 mm (6 mil). The automatic watering programming system included a programmer for irrigation and a water meter for measuring the flow rate.

The system was placed at the entrance to the solar system, being connected to the secondary water supply pipe and fertilizer solution. The FLORABEST programmer was used in the installation. The flow measurement was done using a water meter located before the programmer, which made the amount of water that was administered through the buses recorded.

The biological material used for the experience of the protected area within the vegetable sector of the "Vasile Adamachi" Farm consisted of a tomato crop (*Lycopersicon esculentum Mill*.), The *F1 Minaret* hybrid, for which the specific crop technology was respected. The setting up of the crops was carried out in a tunnel type solar, with a width of 5.4 m and a length of 25 m, with a plant density of 31.740 plants /ha. *Minaret F1* (fig. 2) is a fast-growing, semi-finished and uniform fruit early tomato hybrid, being recommended for cultivation in greenhouses and solariums or in the open field. Hybrid has high resistance to drying and vascular wasting. The fruit has a uniform, intense red color with a mass of between 180 and 200 g. The plant exhibits rapid growth, stable vegetative-generative balance and nematode tolerance.

The vegetable plants under study were grouped into four experimental variants (tab. 1):

Table 1

Variantele experimentale pentru tomate – 2017

Experimental variants	Method of fertilization	Irrigation method
V_1	Through the irrigation water	Dripping
V_2	Dispersal	
V_3	Microorganisms	
V_4	Unfertilizedt	

Fig. 2 Hybrid *Minaret F1*

Tomatoes were planted in strips with a distance of 80 cm between them. The distance between the rows in the band was 60 cm and the distance between the plants in turn, 45 cm, resulting in a density of 31,740 plants/ha. For protection, a plant tape was created from the same hybrids (Corduneanu *et al.,* 2015).

V_1 plants were fertilized simultaneously with drip irrigation, twice a week, fertilizing after sunrise.

In the first stage of vegetation, Nutrispore - NPK (MgO) 30-10-10 water borne fertilizer was used, Bor (B), Iron (Fe), Manganese (Mn), Zinc (Zn) promoting rhizobacteria). In the second application, Nutrispore® NPK (MgO) 15-10-30 was administered with Bor (B), Iron (Fe), Manganese (Mn), Zinc (Zn) and Nutrispore® NPK 12-48- 8, Boron (B), Iron (Fe), Manganese (Mn), Zinc (Zn) for the same V1 plants. Weighing the fertilizer was performed with an accurate electronic weighing scale (precision of 0.01 g). For the best fertirigation, plant nutrition was performed periodically, twice a week, between two consecutive waterings, thus preventing clogging of the plant (Corduneanu *et al*., 2015; 2016). The fertigation was carried out in the first step by opening the drip irrigation line, fed from a constant water level basin for 10 minutes to fill the drip tapes. During this time, the fertilizer tank was fed with 30 l of water. The fertilizer solution obtained separately by mixing the water-soluble fertilizer with water was introduced into the fertilizer tank where the final mixture was made by means of a stirrer. In order to introduce the fertilizer solution into the watering system, the fertilizer tank valve and the automatic watering system were opened, so that the fertilizer was introduced into the irrigation water that came to the plant via the bus and then the secondary pipe by means of a drip irrigation tap (Corduneanu *et al.,* 2015; 2016). The water supply to the solar system was achieved by opening the tap. The amount of water is recorded by a water meter. Once the tap is opened, the fertilizer solution in the fertilizer tank goes into the irrigation water via the hose connected to an automatic programmer. From the moment the mixture is made, the nutrient water feeds the water distribution pipe to which the drip irrigation tapes adjacent to each plant are connected. After completion of the fertilization, dripping was also carried out for 10 minutes to ensure complete elimination of the fertilizer solution in the system.

Plants of variant $V_{2,}$ subject to classical nutrition (fertilizer spreading around the plant) were fertilized with Cristaland® NPK 20-20-20 fertilizer applied to basic fertilization, Cristaland® NP 15-50 + 2MgO, applied in the floral button phase (the first inflorescence), and Cristaland® NPK 9-18-27 + 2 MgO, applied in the formation of first fruits phenophase.

The V_3 plants were fertilized with Micoseed® MB microorganisms fertilizer spread around each plant applied to the field preparation 2-3 days before planting. According to the literature, Micoseed MB is a fertilizer based on Glomus sp., Beauveria sp., Metarhizium sp. and Trichoderma sp. (Stoleru *et al.,* 2014). Also in this variant, during the vegetation period two fertilizations with Nutryaction® were applied, in order to increase the biological activity of the plants. In V4 variant, the plants were not fertilized, constituting the control sample, to which drip irrigation (Corduneanu *et al.*, 2015; 2016; 2017).

Drip irrigation was performed every two days, two hours per day, respectively 8.00 ... 10.00 or 7.00 ... 9.00, depending on the temperature. A watering cycle consisted initially from the opening of the main water tap, at the same time as the tap was opened at the entrance to the solar system. By opening the first tap, the main water supply pipe was fed, and with the opening of the second tap, the supply of the secondary distribution pipe could be provided. Once the latter was filled, it was possible to fill the watering strips, parallel to the rows of plants, so that the watering itself can be done by means of the drippers on each strip. Gut irrigation was done so that the furrows were filled with water, irrigation lasting an average of 30 minutes.

Biometric measurements were made weekly (fig.3), whereby the growth dynamics of the plants were determined, depending on the variant, by following the number of flowers/ fruits on a plant and the mass of the fruit. Biometric measurements were made by the study of five tomato plants of each variant (Corduneanu *et al.,* 2015; 2016; 2017). Determination of the fruit mass was performed by weighing five fruits of the current crop of each variant.

Fig.3 Fruits taken into study

Harvesting (fig. 4) was made in staggered manner, by variants, recording the quantity of fruit obtained in each variant. The resulting vegetables were weighed with an electronic precision weighing scale.

Fig.4 Tomato yield

RESULTS AND DISCUSSIONS

Influence of fertilizer and watering method on the number of fruits of tomato plants

The number of fruit per plant varied considerably from 12.26 fruit to unfertilized and drip irrigation, up to 17.69 fruit in drip irrigation and microorganism-based fertilizer application. Approximate values were recorded for the fertilized variants by the drip irrigation system and the fertilized ones, with 15, 83 fruit at V1 and 14,51 at V2 variant (tab. 2).

Table 2

Number of fruits per plant

Experimental variant	Date of harvest (2017)							Average
	17.05	27.05	3.06	10.06	29.06	7.07	17.07	
V_1	0	0	0.60	4.60	28.00	36.40	41.20	**15.83**
V_2	0	0	0.80	4.00	25.00	31.40	40.40	**14.51**
V_3	0	0	1.60	5.20	28.80	41.80	46.40	**17.69**
V_4(Mt)	0	0	1.00	4.00	22.00	24.00	35.00	**12.26**

The difference of 5.40 fruit per plant, compared to the control, obtained in variant three, fertilized with microorganism-based fertilizers, is considered distinctly significant. A distinctly significant difference of 3.54 fruits per plant was also obtained in the V_1 fertilized variant (tab. 3). The classic fertilized variant, V_2, made a difference from the control of 2.22 fruit per plant, and was considered poorly.

Table 3

Results on the number of fruits per plant (2017)

Experimental variant	Nr. of fruit per plant	The relative value %	The difference from the witness	The significance of the difference
V_1	15.83	128.80	3.54	**
V_2	14.51	118.06	2.22	*
V_3	17.69	143.94	5.40	**
V_4 (Mt)	12.29	100.00	0.00	ns

DL 0.1% = 5.90; DL1% = 3.47; DL = 5%

Influence of fertilizer and watering method on tomato fruit mass

The mass of tomato fruit was influenced by the watering and fertilization method, so that a value of 248.47g / fruit was obtained in the drip irrigated and non-fertilized variant. In variants fertilized by the classical method and by microorganisms (both by spreading around the plant), the obtained values were somewhat close, of 254, 41 g / fruit for V3 and 251.73 g / fruit. The highest value was recorded by the plants of fertilized variant, V1, where the average mass of a fruit was 270.66 g / fruit (tab. 4).

This value demonstrates the importance of localized application of water and fertilizer in terms of fruit mass, and implicitly influences final production.

Table 4

Table of tomato fruits (g)

Experimental variant	Date of harvest (2017)					Average
	11.07	19.07	25.07	2.08	17.08	
V_1	235.78	279.72	220.62	335.10	282.08	**270.66**
V_2	198.36	232.94	258.30	308.24	274.20	**254.41**
V_3	158.64	224.98	281.38	307.06	286.58	**251.73**
V_4(Mt)	234.98	234.02	247.38	267.56	258.40	**248.47**

The statistical analysis shows that the fertilization mode did not significantly influence the fruit mass (tab. 5).

Table 5

Rezultatele privind masa fructelor de tomate (2017)

Experimental variant	Nr. of fruit per plant	The relative value %	The difference from the witness	The significance of the difference
V_1	270.66	108.93	22.19	ns
V_2	254.41	102.39	5.94	ns
V_3	251.73	101.31	3.26	ns
V_4 (Mt)	248.47	100.00	0.00	ns

DL 0.1% =85.88; DL1% = 50.45; DL =32.18%

Influence of the method of fertilization and watering on the production of tomatoes

In the crop year 2017, the production ranged from 113.19 t/ha for variant V_4, drip irrigation, unfertilized to 165.62 t/ha for the fertilized variant (Table 6).

The difference from the control, of 52.43 t/ha, is considered positively very significant. Therefore, in the case of tomatoes, it is found that the experimental variant to which fertilization has been applied is clearly superior to the other variants in fruit production per hectare. In 2017, the establishment of tomato culture was carried out after a large bean culture *"Phaseolus coccineus L."* and there is the possibility of resilience of mineral elements.

Table 6

Tomato production (t/ha) **– 2017**

Experimental variant	Total production (t/ha)	Relative production (%)	The difference from the control (t/ha)	The significance of the difference
V_1	165.62	146.32	52.43	***
V_2	125.23	110.64	12.04	*
V_3	138.67	122.51	25.48	**
V_4 (Mt)	113.19	100.00	0.00	ns

DL 0.1% =31.56; DL1% = 18.54; DL =11.82%

CONCLUSIONS

Experimental research in protected space was carried out in Horticultural Farm No.3 "Vasile Adamachi" in Iasi, in a semicircular solar tunnel with a surface of 135 m^2.

To achieve the experiences of the vegetable sector, was chosen a tomato culture (*Lycopersicon esculentum Mill*.), *Minaret F1* hybrid.

The experiments were carried out with a drip irrigation system consisting of a fertilizer tank, automatic watering programming system and water distribution system.

There were four experimental variants. Experience has been influenced by the fertilization method (fertilization, classic and microorganisms) for a protected tomato crop.

Biometric measurements determined the number of flowers/fruit, fruit mass and production.

The average values of the number of fruit per plant in the crop year 2017 recorded values ranging from 12.26 fruit to the unfertilized variant and 15.83 fruit per plant in the variant where drip fertilization was used.

The mass of tomato fruits varied, depending on the fertilization method used, from 246.71 g in the control variant to 270.66 g in the fertilized variety.

Tomato production showed a difference of 52.43 t/ha compared to the witness, being considered very significant.

In the case of tomatoes, it was found that the experimental variant to which fertilization was applied is clearly superior to the other variants in fruit production per hectare.

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