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RESEARCH ON THE INFLUENCE OF DRIP FERTIGATION ON A SWEET PEPPER AND TOMATO PRODUCTION IN A TUNNEL

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Abstract: *The research that makes the subject of this paper aimed to reveal the influence of fertilization along with drip irrigation in a crop of peppers and tomatoes placed in a protected space. The experiments were conducted in a solar belonging to the Vegetable discipline, located in the "V. Adamachi" Didactic farm in Iasi. The objective of the investigation is to determine the effect of the fertilization method, using conventional fertilizers based on micro-organisms and simultaneously with drip irrigation, compared to an unfertilized version. Thus, after the fertigation, differences were found in terms of production per hectare, in the case of the two cultures. The production obtained by the Brillant F1 pepper cultivar in the fertigated version was of 85,850 kg/ha and the production of the Minaret F1 tomato cultivar, of 92,076 kg/ha.*

Keywords*: fertigation, sweet pepper, production, tunnel.*

1. Introduction

Drip irrigation has been recognized as a sensible method of supplying water inside the greenhouses, and a simple method for drip irrigation scheduling at low cost is urgently required[1].
Drip fertigation, a technique used to manage soil water and nutrition supplies according to the actual water and nutrient requirement of the plants, can be applied to vegetable production to maintain stable water and nutrition contents in the root zone of crops. It applies frequent and small amounts of soluble fertilizers along with water by exerting the soil buffer characteristic and by reducing the time interval between successive irrigations. [2], [3].
Drip watering facilities consist of: water preparation group, that provides connection to water, water filtration, management of the fertilizers in the irrigation water, pressure and flow regulation and measurement; irrigation equipment, consisting of transport pipes, irrigation pipes, dropping devices and system monitoring equipment [4].
The efficiency of a fertigation treatment can be evaluated with a combination of the availability and distribution of soil water and nutrients, the growth and development of crop root, and the formation of crop yield. These parameters are relatively simple, rapid, easy to obtain and cost effective. Among these, particular attention should be paid to plant root since the morphology and spatial configuration of root can significantly affect soil water and nutrient transformation, mobilization and use efficiency by plant and crop yield [5]-[7].
By fertigation, we can establish: the applied amount, the duration of the applications, the proportion of fertilizers, the start and the end of the application. A fertigation system comprises a Venturi injector head control, metering pumps, a fertilizer tank and automatic timers [8].
Vegetable crops are the eminent source of human nutrition and represent a dynamic segment of agriculture [9].
Drip irrigation reduces crop evapotranspiration (ET) and deep percolation, but increases fruit number, fruit size and soluble solid content of tomato, so it improves yield, fruit quality and water use efficiency and decreases the danger of soil degradation and salinity [10].
Sweet pepper (*Capsicum annuum L.*) is one of the most important vegetables that are consumed worldwide, after tomatoes and onions [11].

Drip irrigation system coupled with fertigation could increase sweet paper yield up to an extent of 60% over surface irrigation with less quantity of water [12].
Water plays an important role in plant life and in determining the yield of tomato [13]. Tomato *(Lycopersicon esculentum Mill.)* requires a constant and adequate water supply during the growing season because it is sensitive to water stress, especially during the reproductive stage [14].

2. Material and method

The research was carried out in a semicircular solar (Figure 1), with an area of 270 m2, located in "V. Adamachi Didactic Farm, within USAMV Iasi. On the surface of the solar, two experiments were performed for two species of vegetables, tomatoes and peppers, arranged alternately in the same number of versions (Table 1). The studied plants belong to the Brillant F1 pepper cultivar and to the Minaret F1 tomato cultivar, grouped into four experimental versions (Table 1), on tapes, the distance between the tapes being of 80 cm, between the rows per tape, of 60 cm, and the distance between the plants in a row, of 45 cm, resulting in a density of 31,740 plants ha (Figure 1).
The experimental protection tape was established with the same, unfertilized hybrid.

Fig. 1. The establishment of the experiment
A – solar; B – distance between tapes; C – distance between rows on a tape; D – distance between plants in a row.

TABLE 1: Experimental versions (2016)

Experimental versions	Fertilization methods
V_1	Drip fertigation - using soluble fertilizer
V_2	Classic fertilization – by spraying on the soil surface and incorporated
V_3	Microorganism fertilization- by spraying on the soil surface and incorporated
V_4	Unfertilized (Mt)

Within the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad" Iaşi, in order to fertilize the vegetable crops through the irrigation water from the protected spaces, a facility was designed and built.
This facility consists of a fertilizer tank, a watering programming automatic system, and a watering line (Fig. 2).
To perform the experiments, a fertigation facility was designed and built, within the disciplines of Agricultural Engineering, consisting of a water tank with constant watering, with a capacity of 20 tons, a tank for the preparation of the concentrated solution of fertilizer, a watering line and an automatic watering programming.

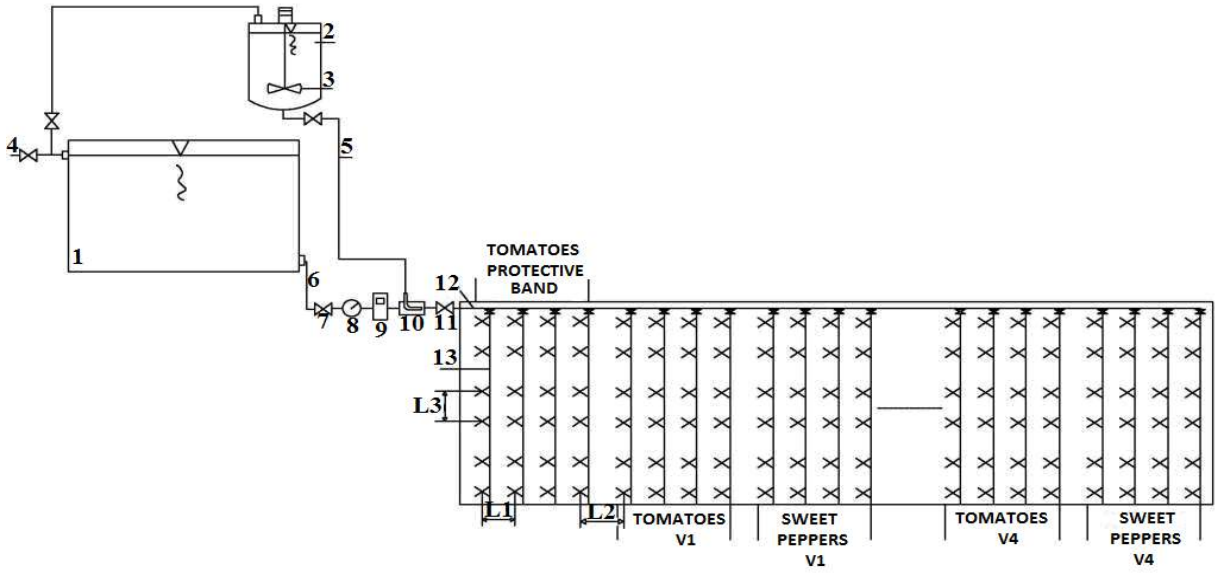

Fig. 2. Organization and location of the experiment

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 - meter; 9 - programmer; 10 - ejector for mixing the water-fertilizer solution; 11 - water meter; 12 - main pipe; 13 - dropping pipeline; L1 - spacing between rows on tape (60 cm); L2 - distance between tapes (80 cm); L3 - distance between plants in a row (45 cm).

The fertilizer tank used in the fertigation system in the experiment had a capacity of 300 liters, was made of metal, was resistant to mechanical shocks and chemical ones.

On the outside, the tank was graduated from 10 to 10 L, the reading being performed with the help of a transparent tube mounted on the side, operating on the principle of capillary action.

The top of the tank was provided with an inlet, through which the water was introduced to the mixture of water and fertilizers. The mixture solution in the tank was carried out by an agitator, being driven by an electric motor.

At the bottom of the tank, there was the outlet of the solution, which was provided with an opening valve and a discharge hose. The fertilizing solution passed through the ½ "hose in the main watering line.

Within the fertigation facility created at USAMV Iasi, the type Y, 1" TORO filter was used. Made of plastic, it ensures durability and corrosion resistance. It presents a cover that allows easy and quick cleaning, a removable filter, disc type, 120 mesh, the contact with the water basin being made with an external thread of 3/4 ". The flow rate is of 7 m³/h, with a pressure loss of 0,001 MPa.

For the plant irrigation, a drip watering line consisting of the main line, the secondary line and the watering line, with the tape diameter of 16 mm and the distance between the drainers of 10 cm, was used.

The main water distribution pipe (figure 3), made of polyethylene, with a diameter of 1 'and 55 m in length, made contact with the secondary water distribution pipe, located in the solar, component of the watering line. The main pipe was connected by a series of fittings and accessories to the water basin that fed the system.

Fig. 3. a – filter: 1, 3 – filter case; 2 – disc type filter; 4 – outlet valve
b – main water distribution pipeline

The secondary water distribution pipe (Figure 4) was placed perpendicularly to the plant rows and was meant to feed the watering tapes representing the active part of the drip irrigation system.
The watering equipment is the terminal part of the facility, consisting of transport and watering pipelines, with provisions for the water distribution to the plant.
The connection between the water pipe and the drip tape was made by the valves, which may be also used as starting connectors. The distance between the holes in the watering band is of 10 cm, the diameter, of 16 mm, and the wall thickness, of 0.15 mm (6 mil).
In order to automate the watering program, a computer programmer was used for irrigation and a water meter for the measurement of the traffic flow. The system has been installed at the entrance of the solarium, being connected to the secondary water and fertilizing solution distribution pipe. The irrigation programmers are computers that provide the exactly watering time, by setting the desired duration and the watering interval.
Within the facility, the FLORABEST programmer (Figure 4) was used, having the following characteristics:

- possibility of adjusting two daily watering intervals, adjustable irrigation time, between 1 minute and 23 hours 59 minutes;
- selectable irrigation rate between daily to 1 time per week;
- manual water intake by pressing a button;
- protected case against splash water (IPX4) with transparent protective cover;
- use for standard valves with threaded of 33.3 mm (G1 "), includes a threaded adapter of 26.5 mm (G3 / 4").

The programmer comprises an opening valve, a fertilizing solution circulation hose connected to the fertilizer tank and a secondary water distribution pipe.

Fig. 4. Automatic watering schedule
1 – irrigation programmer; 2 – fertilizing solution hose; 3 – apometer; 4 – way valve.

The flow rate was measured using a water meter with an accuracy of 0.0001m3, the maximum working temperature being of 30 degrees and the maximum operating pressure, of 16 bar, located in front of the programmer, through which the administered amount of water is recorded.
During the growth cycle, it has been administered an amount of water equivalent to 5600 m3/ha, the watering being carried out every other day, in the time range 8.00-10.00 7.00-9.00, based on the recorded temperature.
The plants in V_1 version were fertilized along with drip irrigation at the, two times a week, the fertigation being carried out in the morning. It was used Nutrispore® fertilizer - NPK (MgO) 10/30/10 - 300 kg/ha, NPK Nutrispore® (MgO) 10/30/15 - 425 kg/ha and NPK 12-48-8 Nutrispore® - 400 kg/Ha. In order to have a good fertigation, the plant nutrition has been carried out periodically, twice a week, between two consecutive waterings.
The plants in version 2 were chemically fertilized, by spreading, on the surface of the soil, in each plant area, in the equivalent of 200 kg/ha NPK 20-20-20 Cristaland®, applied during basic fertilization; 250 kg/ha Cristaland® NP 15-50 + 2MgO, applied in the floral button phase (the first inflorescence) and 200 kg/ha of NPK 9-18-27 + 2 MgO Cristaland®, applied in the first fruit phenophase.
The plants in the V_3 version were fertilized with a micro-organism based fertilizer, Micoseed® MB, by spreading, in each plant area, in the equivalent of 60 kg/ha, applied in order to prepare the ground, 2-3 days before planting the peppers. According to the data from the specialty literature, Micoseed MB® is a fertilizer based on *Glomus sp., Beauveria sp., Metarhizium sp*. and *Trichoderma sp.* [15]. In this version, during the growing season, there were also applied two fertilizations with Nutryaction®, in the amount of 5 L/ha, to stimulate the biological activity of the microorganisms.
In the V_4 control version, there have been applied drip irrigations, under the same conditions as in the V_1, V_2 and V_3 versions. Weekly, biometric measurements were performed, by which the dynamics of the plant growth has been determined, following the height of the plant, the number of flowers and the number of related flowers/fruits.
The pepper and tomato plants were cared for according to data from the specialty literature [16]. The processing of the experimental data was carried out using the analysis of the version (ANOVA), by calculating the limit differences [17].

3. Results and their interpretation

Experimental results concerning the pepper plant growth

The results concerning the production of pepper in 2016 are shown in Table 2. The production of pepper in the experiment ranged very widely, from 55,870 kg/ha in the control version, V_4, up to 85,850 kg/ha in the fertigated version, V_1.

TABLE 2: Results concerning the pepper production (2016)

Experimental version	Total production, kg/ha	Relative production, %	Difference compared to the control (kg/ha)
V_1	85850	153,7	29980***
V_2	64814	116,0	8944*
V_3	56530	101,2	660^{ns}
V_4	55870	100,0	0

DL 5% = 4896 kg/ha; DL 1% = 15520 kg/ha; DL 0,01% = 22472 kg/ha

The difference of 29980 kg/ha, compared to the control version was considered very significant. A significant positive difference was achieved in the classic fertilized version, this being of 8944 kg/ha.
The version fertilized with microorganisms, V_3, made a difference compared to the control, of 660 kg/ha, and is considered insignificant.

Experimental results concerning the tomato production (2016)

The results concerning the tomato production obtained in 2016 are revealed in Table 3. The production of tomato in the experiment varied within a wide range, from 69,651 kg/ha in the unfertilized version, $V_{4,}$ to 92,076 kg/ha in the fertigated version, V_1.

TABLE 3: Results concerning the tomato production (2016)

Experimental version	Total production, kg/ha	Relative production, %	Difference compared to the control (kg/ha)
V_1	92076	132,2	22425^{**}
V_2	76148	109,3	6497^{ns}
V_3	89330	128,3	19679^{**}
V_4	69651	100,0	0

DL 5% = 5891 kg/ha DL1% = 18674 kg/ha DL0,01%= 27039 kg/ha

In the tomato crop, the difference of 22425 kg/ha, compared to the control was considered significant. A significant positive difference, too, was performed in the mocroorganism fertilized version, of 19679 kg/ha. The classic fertilized version, V_2, recorded a vast difference from the witness, 6497 kg/ha, being considered an insignificant difference.

4. Conclusions

The pepper production of the *Brillant F1* hybrid and the *Minaret F1* tomato production, in 2016, within the experience, obtained the highest values in the fertigated version, V_1. The difference from the control, in the production of pepper, of 29980 kg/ha, and of 22425 kg/ha, in the tomato production, demonstrates that the version where fertigation was used made a decisive distribution in time and space of the fertilizer, in the system root, distribution performed uniformly during the growing season.

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