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Producción de tomate (*Solanum lycopersicum*) en macro túnel para Úrsulo Galván, Veracruz, México

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Abstract

Nowadays, the irrational and excessive use of agrochemicals brings with it many consequences not only to soils and plants, but also to human beings, that is why it is important to test fertilization doses to the crops that are established in an area or place. An alternative could be agricultural production under new production systems such as vegetable production in macro-tunnels. One of these crops is tomato, since the amount of products applied is considerable, however, determining the appropriate dose for the Ursulo Galvan region is an investigation that could be a spearhead. This research was carried out through a completely randomized experimental design, using 5 treatments and 10 replications, finding through an ANOVA and a Tukey test for comparison of means ($\alpha \geq 0.05$), that, although for the variables height, diameter, number of branches there was no statistical difference, the best treatment in terms of yield was treatment 2, because it is the one that produces the most. Therefore, this work is interesting because it is not the highest fertilization dose, but the one that produces the most.

Irrational, Production, Fertilization

Resumen

En la actualidad el uso irracional y excesivo de agroquímico trae consigo muchas consecuencias no solo a los suelos y plantas, sino también al ser humano, por ello es importante probar dosis de fertilización a los cultivos que se establecen en una zona o lugar. Una alternativa podría ser la producción agrícola bajo nuevos sistemas productivos como lo es la producción de hortalizas en macrotúneles. Uno de estos cultivos es el tomate, pues la cantidad de productos que se aplican es considerable, sin embargo, el determinar la dosis apropiada para la región de Úrsulo Galván es una investigación que podría ser punta de lanza. Esta investigación se llevó a cabo mediante un deseño experimental completamente al azar, utilizando 5 tratamientos y 10 repeticiones, encontrando mediante un ANOVA y una prueba de comparación de medias por Tukey ($\alpha \geq 0.05$), que, si bien para las variables altura, diámetro, número de ramas no se presento diferencia estadística, el mejor tratamiento en cuanto a rendimiento fue el 2, debido a que es el que más produce. Por ello lo interesante de este trabajo pues no es la dosis de fertilización más alta.

Irracional, Producción, Fertilización

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Introducción

The tomato crop is the vegetable with the highest economic value worldwide, and its consumption is constantly increasing due to population growth and the need to use it in food processing (Ortega-Martínez et al. 2010). The characteristics and nutrients that constitute this crop make it one of the main complements used for food processing, as well as for its antioxidant properties (Fraser et al. 2009; Espinoza-Palomeque et al. 2017). In Mexico alone, this species occupies 70% of the total protected agriculture cultivated in the country (Juárez-Maldonado et al. 2015).

The irrational increase of the population has brought with it modifications to production systems, because although greenhouses can be an alternative to increase production, other structures can also bring benefits in increasing production, with lower investments (Aguilar-Rodriguez et al. 2020).

For some years now, producers have been interested in new production systems that favor yields (Santiago-López et al. 2016). The above is also due to the fact that one of the factors limiting production is the soil, because of salinization, loss of fertility and physical deterioration, which also generates the need to seek new technologies or production systems for the crop to express its maximum productive potential (Peña et al. 2014).

However, the development of high-yielding materials requires technical knowledge, including genetics, which is one of the main components for this characteristic to be expressed or manifested, since it is combined with the agronomic management of the crop so that it can be manifested (Bayomi et al. 2020).

Therefore, the objective of this research was to determine the production of tomato cultivation in a macro-tunnel and to assess whether this can be an option in the region of Ursulo Galvan, Veracruz, Mexico, so that producers can expand their range of crops and obtain better income.

Description of the method

Location

The present experimental work was carried out at the Tecnológico Nacional de México Campus Úrsulo Galván, located in the Municipality of Villa Úrsulo Galván, Veracruz, Mexico, geographically located at parallels 19° 24′ 40.92″ north longitude and 96° 21′ 33.32″ west latitude, with an elevation of 9 masl.

Treatments

The treatments tested or implemented were 5, whose chemical composition or fertilizer content can be visualized in Table 1.).

Treatment	Urea – Dap – KCl (g)
1	150 – 200 – 275
2	75 – 100- 137.5
3	225 – 300 – 412.5
4	300 – 400 – 550
5	Witness

Table 1 Description of treatments
Source: Own elaboration

Experimental design

A completely randomized design was used, consisting of five treatments and ten replications, with a total of 50 experimental units. Planting was carried out at a distance of 40 cm between plants and 1 m between rows, with a stocking density of 25,000 plants per hectare per day.

Variables to be evaluated

Plant:

- Height.
- Diameter.
- Number of branches.

Fruit:

Performance

Statistical analysis

The results obtained were analyzed in the SAS program, after which a comparison of means test was performed using Tukey's method**.** ($\alpha \geq 0.05$).

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Results

For the variable plant height we found that there is no statistical difference in any of the samplings carried out from November 15 to December 13, 2019. So we could say at first that, whether we add fertilizer or not, we will have the same height, it is important to mention that, despite not applying fertilizer to the soil, foliar applications were made, which may be the reason why we did not find statistical difference (Table 2). The above differs from what was investigated by Martínez et al. (2014) as they had heights even higher than 2 m, however, they carried out their work in greenhouses, additionally their plants were of indeterminate growth and only left 2 branches, pruning the rest. But Luna-Murillo *et al*. (2015) obtained lower results because they conducted their research in open field and the soil fertilization was with vermicompost.

Treatment	1 (cm)	2 (cm)	3 (cm)	4 (cm)	5 (cm)
1	22.3 a	47.61 a	68.70 a	83.99 a	119.87 a
2	18.42 a	47.75 a	70.11 a	86.63 a	141.62a
3	19.80 a	45.21 a	66.63 a	84.43 a	126.46 a
4	20.66 a	47.75 a	69.29 a	87.09 a	127.39 a
5	21.69 a	50.08 a	75.37 a	89.62 a	138.32 a
1: December 15, 2019; 2: November 22, 2019; 3: November 29, 2019; 4: December 06, 2019 and 5: December 13, 2019. Equal letters indicate no statistical difference.					

Table 2 Mean comparison data by Tukey's α 0.05 method, for plant heights
Source: Own elaboration

In relation to the variable stem diameter, we found that there was no statistical difference between treatments according to the samples taken from November 15 to December 13, 2019. Possibly for this variable as well as for plant height, this effect could be influenced by the foliar fertilization that was supplied (Table 3). According to Luna-Fletes et al. (2021) they obtained similar results for this variable, although they worked with other tomato material, and in their research they did find a statistical difference. However, Ramos-Otinario et al. (2021) report results lower than diameter, so it is considered interesting what was found in their research for this variable.

Treatment	1 (mm)	2 (mm)	3 (mm)	4 (mm)	5 (mm)
1	3.9 a	4.4 a	5.1 a	6.1 a	9.4 a
2	3.3 a	4.0 a	5.1 a	6.0 a	10.2 a
3	3.1 a	3.8 a	4.9 a	5.8 a	10.3 a
4	3.0 a	4.2 a	4.7 a	5.9 a	10.7 a
5	3.5 a	4.4 a	5.6 a	6.1 a	11.1 a
1: December 15, 2019; 2: November 22, 2019; 3: November 29, 2019; 4: December 06, 2019 and 5: December 13, 2019. Equal letters indicate no statistical difference					

Table 3 Mean comparison data by Tukey's α 0.05 method, for plant diameters
Source: Own elaboration

In the case of the variable number of branches, according to the statistical analysis, we found that there was no difference for the samples taken from November 15 to December 13, 2019. Therefore, as in the two previous variables, the agronomic management provided is what helps to avoid the statistical difference (Table 4). According to Ruíz et al. (2008) the results provided are different because they obtained a smaller number of branches, but in their research a statistical difference was found.

Treatment	1	2	3	4	5
1	5.2 a	6.2 a	7.1 a	9.1 a	9.4 a
2	4.4 a	6.4 a	8.9 a	9.3 a	10.2 a
3	4.7 a	6.7 a	8.6 a	9.3 a	10.3 a
4	5.0 a	7.0 a	9.3 a	10.7 a	12.5 a
5	4.8 a	7.2 a	9.7 a	10.4 a	12.6 a
1: December 15, 2019; 2: November 22, 2019; 3: November 29, 2019; 4: December 06, 2019 and 5: December 13, 2019. Equal letters indicate no statistical difference.					

Table 4 Mean comparison data by Tukey's α 0.05 method, for numbers of branches on plants
Source: Own elaboration

For the variable total yield in different cuts, we found that there is a statistical difference, with treatments 2 and 4 being the best and exceeding 500 g of production per plant (Table 5). While for this variable the results differ from those published by Luna-Fletes et al. (2021) because they obtained higher yields than these, however, it is important to mention that they used another species, as well as another production system.

Treatment	1 (g)	2 (g)	3 (g)	4 (g)	Total
1	96 a	128.5 a	95.5 a	103.5 b	423.5
2	0.0 c	112.0 ab	128.0 a	337.8 a	577.8
3	44.5 cb	48.0 b	175.5 a	97.0 b	365
4	95.0 a	91.6 ab	170.0 a	217.5 ab	574.1
5	48.0 b	101.1 ab	125.0 a	225.0 ab	499
1: December 15, 2019; 2: November 22, 2019; 3: November 29, 2019; 4: December 06, 2019 and 5: December 13, 2019. Equal letters indicate no statistical difference.					

Table 5 Mean comparison data by Tukey's method α 0.05, for fruit yield
Source: Own elaboration

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With a yield ha-1 of more than 14 tons, which is quite acceptable because the investment made in the macro-tunnels is not high compared to the construction of a greenhouse (Table 6). However, we agree with Aguilar-Poaquiza et al. (2021), in the sense that strategies should be designed for the commercialization of agricultural products and thus generate better income and marketing methods.

Treatment	Yield in kg ha^{-1}
1	10,587.5
2	14,445.0
3	9,125.0
4	14,352.5
5	12,475.0

Table 5 Yield data ha-1 obtained with the macro tunnels
Source: Own elaboration

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Conclusions

Based on the results obtained at first, we could say that for the variables height, diameter and number of branches, we found that there is no statistical difference, which may be due to the nutritional management applied to the crop, that is, although treatment five was not fertilized, the foliar spraying contributed to the fact that there was no statistical difference.

However, for yield, we found that the best treatments were 2 (75 - 100 - 137.5) and 4 (300 - 400 - 550), the former being the one with the highest production. This is quite logical since they are chemical fertilizers and the foliar applications were not enough for the yield, that is why it is lower. But the information obtained is very interesting, at least in the region of Ursulo Galvan, Veracruz, Mexico. It is information that serves as a base or spearhead, to generate more knowledge in the area and assess whether this crop, with this production system could be an alternative in the region. Finally, we consider it important to repeat this research at least in one or two more cycles to evaluate if the behavior continues in a similar way or if there is any change, so it is interesting to continue with the evaluation of this type of work, with the intention of knowing how a crop behaves with this type of production system.

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