EVALUATION OF ORGANIC FERTILIZERS USING OREGANO PLANTS (ORIGANUM VULGARE) AS AN INDICATOR

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Abstract
The purpose of this research was to evaluate the efficiency of different types of organic fertilizers in the growth of Oregano plants (Origanum vulgare). A completely random block design was applied, four treatments were evaluated (4): Organic Compost (T1), Manure Fertilizer (T2), Vermicompost (T3) and a Control (T4). Variables per plant such as Stem Length, Stem Diameter, leaf area, fresh weight of the plant and height were measured. The results revealed significant differences between the averages of the treatments, which affirms that organic fertilizers significantly influenced the growth and yield of the plants. With the leaf area indicator in treatment T1, plants reached 8820.43 cm2, with T2 plants of 7784.45 cm2 and T3 obtained plants with 8085.31 cm2. All treatments surpassed, in terms of real value, T4 which only reached plants with 7580.13 cm2 of leaf area.
Keywords: Organic fertilizers, Vermicompost, manure, Leaf area, *Origanum vulgare*.

INTRODUCTION

In recent years, the diversity and materials used in the continuous production of sustainable and environmentally friendly agricultural practices have spread to a wide territory, increasingly focusing on the use of organic fertilizers (Ceritoğlu- Mustafa et al., 2018). These, derived from natural sources, not only enrich the soil through the recycling of essential nutrients, but also promote ecosystem health and the production of healthier food.

This study focused not only on evaluating the efficiency of different organic fertilizers in the growth of Oregano (Origanum vulgare), but also sought to provide relevant information for the selection and optimal application of these fertilizers in the production of aromatic plants. The resulting findings not only support the significant influence of organic fertilizers on the growth of Oregano plants, but also offer a solid foundation for decision-making in sustainable and organic agriculture. This study contributes to the body of knowledge about environmentally friendly agricultural practices and lays the groundwork for future research in the field of plant nutrition and the cultivation of aromatic herbs.

A completely random block design was implemented to evaluate four treatments: Organic Compost (T1), Manure Fertilizer (T2), Vermicompost (T3) and a Control (T4). Various variables were measured per plant, including stem length, stem diameter, leaf area, fresh weight of the plant and height. The results obtained revealed significant differences between the averages of the treatments, confirming that organic fertilizers exerted a significant influence on the growth and yield of oregano plants.

Moreno-Ayala et al. (2020) argue that fertilizers represent a considerable benefit for the soil, as the organisms present in it actively contribute to the decomposition of organic matter. This process increases the arable layer, improving soil aeration and fertility. In addition, it can increase the water retention capacity in the soil and, ultimately, has the potential to mitigate erosion caused by factors such as wind and water. Bohórquez et al. (2014) mention that "compost is an alternative for the use of by-products, which must be adjusted to the requirements of Colombian technical standard 5167 for its use as a biofertilizer" (p. 1).

Likewise, in recent decades, emphasis has been placed on both soil yield and product quality, in response to market, consumer and industrial demands. Efficiency in plant production implies that the desired characteristics of the plant are at optimal or near-optimal levels. To achieve these characteristics, factors such as temperature, light exposure, humidity, nutritional requirements and climate must be adjusted to the needs of the plants. Failure to comply with any of these factors can negatively affect the development of the plant, resulting in a decrease in both yield and product quality. Therefore, when environmental conditions are favorable, it is crucial to provide the plant with adequate nutrition to ensure optimal quality in agricultural production (Ceritoğlu- Mustafa et al., 2018).

On the one hand, Skoufogianni, Solomou, and Danalatos (2019), mention that medicinal and aromatic plants represent an essential part of the natural wealth in many countries around the world. In the present study, oregano (Origanum vulgare) was worked with, beyond its role in the kitchen, the authors affirm that it has been historically recognized for its medicinal and aromatic properties. It belongs to the Lamiaceae family and is appreciated for its content of essential oils, mainly carvacrol and thymol, which confer antimicrobial and antioxidant properties.

Argüello et al. (2012) conducted a study whose purpose was to analyze the problems of the Production System and the Value Chain of Oregano. As results, they found the presence of Fusarium spp and Phomopsis sp; rust and symptoms of virosis. It was concluded that it is necessary to generate active associations of producers, in order to concentrate the power of marketing and organization.

In addition, oregano is a resistant plant that can adapt to various soil conditions, making it an ideal candidate to evaluate the quality of organic fertilizers. Its response to the type of fertilization not only influences the quantity and quality of the biomass produced, but also the concentration of these beneficial compounds, becoming a sensitive indicator of soil health (Burgos et al., 2016).

Organic fertilization is based on the use of plant waste, animal waste, residual and industrial sludge, as well as urban waste, which, when processed and applied to the soil, improve its physical, chemical and biological conditions (Álvarez & Flores, 2020). These wastes, in solid, liquid and semi-liquid form, can be used as raw material for the production of organic fertilizers, contributing to solving environmental pollution problems. There are various techniques such as aerobic biodegradation, biodigestion and worm farming aimed at managing these organic wastes.

The combined use of organic fertilizers and synthetic chemical fertilizers in agricultural systems promotes a sustainable and environmentally correct approach. While synthetic fertilizers facilitate the immediate and economical management of specific nutrients, organic materials not only provide nutrients, but also improve soil properties and increase productivity in the long term. The residual effect over time of organic fertilizers is a relevant characteristic for their inclusion in integrated plant nutrition systems, overcoming the limitations they present when used as individual sources. (Da Costa et al., 2018)

Sarango et al. (2022), describe organic compost as a mixture of decomposed organic materials, such as kitchen scraps, garden waste and manure. Its use provides a wide range of essential nutrients for plant growth and improves soil structure while promoting beneficial microbial activity. In the context of this study, organic compost is considered as a balanced source of nutrients to compare with other treatments.

Manure has been historically employed in agriculture due to its economic availability and proximity to rural communities. These residues accumulate in backyards and are later used in agricultural fields (Huerta - Cruz et al., 2019).

However, this practice has led to unwanted consequences for the environment and possible risks to human health. For this reason, it is imperative to implement the management, processing and recycling of manure to convert them into beneficial materials, such as processed organic fertilizers (Huerta - Cruz et al., 2019).

The above is presented as a crucial alternative to mitigate the negative impacts on the environment and human health. That is why this fertilizer stands out as a valuable and traditional option to supply essential nutrients to plants, including nitrogen, phosphorus, and potassium, while simultaneously contributing to improving soil structure.

However, it is essential to recognize that the composition of manure fertilizer once it has gone through the composting processes includes remnants of waste that degrade easily, resulting in an intense and long-lasting effect, as well as more resistant remnants such as lignin and cellulose that generate a less persistent effect. However, all of this can vary depending on the animal source and the decomposition process (Jiménez et al., 2019).

Vermicompost, also known as worm compost, is a type of compost produced by the decomposition of organic materials by worms. This process enriches the compost with nutrients such as Phosphorus (K), Nitrogen (N), Potassium (K) and other micronutrients that promote greater microbial activity in the soil (Ceritoğlu- Mustafa et al., 2018). The presence of bioactive compounds derived from the activity of the worms can influence the development and quality of the plants. As research deepens, it has been discovered that vermicompost not only provides essential nutrients for plants but also contains a wide range of beneficial elements, such as vitamins, hormones, humic substances, and antioxidants. Rehman - Su et al. (2023) indicate that vermicompost, in addition to improving soil health and productivity, also manages to mitigate drought and salinity, combat insect pests and plant diseases, reduce the harmful effects of water stress.

The control group or "witness" is kept without the application of any fertilizer, serving as a base reference to evaluate the impact of organic fertilizers compared to the natural conditions of the soil. This treatment is essential to distinguish the specific effects of each type of fertilizer and understand its contribution to the growth of oregano plants (Matheus et al., 2007).

The Tukey test is highly favored by statisticians due to its effective control over α and β errors in statistics (González, 2010). This test enables the realization of all possible comparisons between pair treatments, making it an integral tool for data analysis. This test is based on the Analysis of Variance (ANOVA) and allows all possible comparisons of two-by-two treatments. In addition, it is applied in cases where the result of the F test for ANOVA treatments is significant, providing an integral form of data analysis, it is especially useful for identifying significant differences between groups and has proven to be a valuable tool in data analysis in various fields of study (García et al., 2001).

The purpose of this study is to evaluate the efficiency of different types of organic fertilizers, in the growth of Oregano plants (Origanum vulgare).

1. METHOD AND MATERIALS

Location and Description of the Experimental Area

The research was conducted at the Popular University of Cesar, located in Valledupar, Cesar, Colombia, South America; Latitude. 10.47412° or 10° 28' 27" north; Longitude. -73.25129° or 73° 15' 5". It was developed on the Villagerico farm located in Chiriguaná, Cesar, Colombia, South America Latitude. 9.36364° or 9° 21' 49" north. Longitude. -73.6017° or 73° 36' 6" west, with an average temperature and relative humidity of 30.7 ºC and 45.4% respectively, the soil is sandy loam.

Obtaining organic fertilizers

The collection and production of the different organic fertilizers, the organic compost, manure fertilizer, and vermicompost were obtained on the Villagerico farm located in Chiriguaná, Cesar, Colombia, with the help of an agronomist under the appropriate parameters.

Obtaining oregano plants: Commercial seeds were purchased at Homecenter and germination was initiated in individual containers. To establish the plantation, the plants with the greatest vitality and development were chosen; from these (called mother plants), cuttings of 4 cm in length were taken.These cuttings were transplanted to the final ground, with due care to prevent any physical damage to the seedlings.

Preparation of the land on Villagerico farm

The transplant was carried out in boxes constructed with wooden boards that were 35 cm high, 1.30 m long and 45 cm wide, with a separation of 0.50 m between spaces. These boxes were filled with a mixture of rice husk and soil extracted from the farm. In each box, 12 oregano plants were sown, totaling 144 plants. The recovery phase of the plants extended for eight days, after which experimentation began with the different organic fertilizers and an absolute control group.

Three boxes were assigned for each type of organic fertilizer (organic compost, manure fertilizer, and vermicompost), as well as three boxes for the absolute control group, in which no type of fertilizer was applied. The boxes designated for each type of organic fertilizer were administered a proportional amount. Through mathematical calculations, it was determined that the area of each box was 0.64 m2 for 12 plants. Proportional adjustments were made and the amounts of fertilizer to be applied to each plant (in grams per plant) were calculated, as indicated in tables 1.

Table 1. Quantità di trattamenti di fertilizzante per ogni pianta di Origano (Origanum vulgare) in grammi

Trattamenti di fertilizzanti		Quantità per ogni pianta (g)
T1	Compost Organico	50
T2	Fertilizzante di Sterco	30
T3	Vermicompost	50
T4	Testimone	0

Note. Sono stati assegnati tre cassoni per ogni tipo di fertilizzante organico T1, T2 e T3, così come tre cassoni per il gruppo di controllo assoluto T4, in cui non è stato applicato alcun tipo di fertilizzante.

Control in the conditions of Oregano (Origanum vulgare)

Fertilisation

The application of organic fertilisers was carried out at the time of sowing, considering the three types of organic fertilisers (organic compost, manure fertiliser and vermicompost), except the control. The intervals were at the beginning of the crop and 30 days after the trial was established, in order to allow the plant to assimilate the elements present in the fertilisers.

Irrigation and Weed Control

During the growth process of the oregano plants (Origanum vulgare) in the experiment, three irrigations per week were carried out, adjusted according to their need to avoid flooding the plants. For weed control, it was carried out manually on a weekly basis.

Pest and Disease Control

No presence of any pest was evidenced, so no chemical compounds were added avoiding the use of pesticides that could affect the plants and the parameters to be evaluated.

Harvest

The harvest was carried out manually after reaching physiological maturity. After carrying out some evaluation, 12 plants were collected for each treatment to be evaluated later.

Evaluation Parameters

To carry out the corresponding evaluations, 12 plants were taken from the 2 rows in the middle part, 6 of these plants for each row, leaving 3 plants at each end. Out of a total of 36 plants per treatment, at this stage, following the protocol described by (Mazzola et al., 2016; Molina, 2019) with some modifications, it was considered to evaluate the Oregano plant (Origanum vulgare) with four criteria as described below: Plant height (cm), Stem length (cm), Leaf area (cm2), was determined with Li-Cor (LI-3000 CAP, USA) and the fresh weight of the plant (g); a caliper with an accuracy of 0.05 mm was used; for weight taking, a digital scale with three decimal places was used. 12 oregano samples were weighed for each treatment in fresh matter.

Research Design and Statistical

Analysis This research study is characterised by its experimental design, where the researcher has deliberately manipulated one or more variables to observe the effects they exert on one or more dependent variables, with the aim of establishing cause and effect relationships between the phenomena studied. A completely randomised block design (CRBD) was implemented, consisting of three treatments: an absolute control (without fertiliser application) and three repetitions for each treatment. Field data collection was carried out at 15, 30, 45 days. In addition, the Tukey multiple range test was applied at 5% probability, using the SPSS statistical package (Statistical Package for the Social Sciences, version 22). It should be noted that the description of a plant's growth and the evaluation of treatments that serve to medicate the accumulation of a plant's biomass need objective indicators that can be statistically validated (Di Benedetto and Tognetti, 2016).

2. RESULTS

Evaluation Parameters

During the evaluation of the growth of Oregano (Origanum vulgare), average results of the evaluated parameters are presented, such as: plant height (cm) (Table 2), stem length (cm) (Table 3), leaf area (cm2) (Table 4) and fresh weight of the plant (g) (Table 5). Measurements were taken every eight days over six weeks, and averages were calculated for each parameter at 15, 30 and 45 days. In Tables 2, 3, 4 and 5, the findings of the Tukey multiple range test are detailed with a significance level of 5%, with the purpose of determining if there are significant differences between treatments T1, T2 and T3 compared to T4 (used as control). In addition, the coefficient of variation (CV) is provided in percentage (%) for each time period.

Table 2. Average height of the plant (cm) at 15, 30 and 45 days in the growth of Oregano (Origanum vulgare) with the application of organic fertilisers

TREATMENT	Oregano plant height (cm)		
	15 days	**30 days**	**45 days**
T1 Organic Compost	15,6 a	33,5 b	41,8 a
T2 Manure Fertiliser	13,7 c	27,8 c	33,5 c
T3 Vermicompost	14,8 b	30,3 a	39,4 b
T4 Control	14,5 b	29,4 c	35,3 c
CV (%)	4.64%	6.84%	8.19%

Note: T1, T2, T3 and T4 are the evaluated treatments. Means with a common letter are not significantly different (p ≥0.05).

Table 2 shows the results of the evaluation of the effect that different types of treatment have on the height of oregano plants over time, measured at 15, 30 and 45 days after the start of the experiment. It is observed that, at 15 days, the average height of the oregano plants was highest in treatment T1 (Organic Compost) with 15.6 cm, followed by T3 (Vermicompost) with 14.8 cm, T4 (Control) with 14.5 cm and T2 (Manure Fertiliser) with 13.7 cm. There are significant differences in T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T3, T2 vs T4 and T3 vs T4.

At 30 days, treatment T1 (Organic Compost) showed the highest average height with 33.5 cm, followed by T3 (Vermicompost) with 30.3 cm, T4 (Control) with 29.4 cm and T2 (Manure Fertiliser) with 27.8 cm. In addition, there are significant differences in T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T3 and T3 vs T4, while in T2 Vs T4 there are no significant differences. In relation to 45 days, treatment T1 (Organic Compost) continued to show the highest average height with 41.8 cm, followed by T3 (Vermicompost) with 39.4 cm, T4 (Control) with 35.3 cm and T2 (Manure Fertiliser) with 33.5 cm. In this last period it was determined that there is a significant difference in T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T3 and T3 vs T4, while in T2 Vs T4 there are no significant differences.

In relation to the coefficient of variation (CV), at 15 days it is 4.64% (low), that is, the data tend to be close to the mean; therefore, there is less relative variability. At 30 days, it is 6.84% (slightly higher than that of 15 days), in such a way that there is a greater dispersion of the data in relation to the mean. That of 45 days is 8.19% (higher than in previous periods). This data represents a greater dispersion in relation to the mean, representing a greater relative variability as time progresses.

It should be noted that Organic Compost (T1) was the most effective treatment to promote the growth of oregano plants, closely followed by Vermicompost (T3). The Manure Fertiliser (T2) showed intermediate results, while the control group (Control, T4) showed the least growth in all measurements.

Table 3. Average stem length of the plant (cm) at 15, 30 and 45 days in the growth of Oregano (Origanum vulgare) with the application of organic fertilisers

TREATMENT	Oregano plant stem length (cm)		
	15 days	**30 days**	**45 days**
T1 Organic Compost	25,3 a	35,5 a	47,6 a
T2 Manure Fertiliser	22,7 b	31,3 c	36,7 c

T3 Vermicompost	23,8 c	33,5 b	40,3 b	
T4 Control	22,6 b	30,4 c	35,3 c	
CV (%)	4.58%	5.28%	10.03%	

Note: T1, T2, T3 and T4 are the evaluated treatments. Means with a common letter are not significantly different (p ≥0.05).

Table 3 presents the results of the effects of different treatments on the stem length of oregano plants over a period of 45 days. It shows that, at 15 days, the average stem length of the plants treated with Organic Compost (T1) was the highest at 25.3 cm, followed by Vermicompost (T3) with 23.8 cm, Manure Fertiliser (T2) with 22.7 cm, and the control group (Control, T4) with 22.6 cm. Regarding significant differences, it is observed that there are differences in T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T3 and there are no significant differences in T2 vs T4, T3 vs T4.

At 30 days, the average stem length of the plants in treatment T1 (Organic Compost) was the highest at 35.5 cm, followed by T3 (Vermicompost) with 33.5 cm, T2 (Manure Fertiliser) with 31.3 cm, and T4 (Control) with 30.4 cm. Taking into account this time range, it is observed that there are significant differences in T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T3 and there are no significant differences in T2 vs T4, T3 vs T4.

At 45 days, the average stem length of the plants in treatment T1 (Organic Compost) continued to be the highest at 42 cm, followed by T3 (Vermicompost) with 40.3 cm, T2 (Manure Fertiliser) with 36.7 cm, and T4 (Control) with 35.3 cm. In this period there were significant differences in T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T3 and there were no significant differences: T2 vs T4, T3 vs T4.

It should be noted that, the treatment (T1) had the greatest effect on the growth of stem length compared to the other treatments and the control group. The (T3) also showed a significant positive effect on stem growth, followed by Manure Fertiliser (T2). Therefore, it can be determined that the use of Organic Compost and Vermicompost can be beneficial when wanting to promote the growth of stem length in oregano plants compared to the use of other fertilisers.

As for the CV, it is lower at 15 and 30 days (4.58% and 5.28%), which means that these data are more consistent in relation to the mean. However, at 45 days, the CV significantly increases to 10.03%, representing a greater relative variability in the data at this point in time.

Table 4. Average leaf area (cm2) at 15, 30 and 45 days in the growth of Oregano (Origanum vulgare) with the application of organic fertilisers

	Oregano plant leaf area (cm2)		
TREATMENT	**15 days**	**30 days**	**45 days**
T1 Organic Compost	4241,13 a	5589,26 a	8820,43 a
T2 Manure Fertiliser	3987,30 b	4756,23 b	7784,45 c
T3 Vermicompost	4147,40 a	5373,13 a	8085,31 b
T4 Control	3983,13 b	4558,25 c	7580,13 c
CV (%)	2.97%	8.52%	5.10%

Note: T1, T2, T3 and T4 are the evaluated treatments. Means with a common letter are not significantly different (p ≥0.05).

Table 4 shows the results of the evaluation of the leaf area of oregano plants under different treatments at 15, 30 and 45 days. The coefficient of variation (CV) in percentage is also included for each period, which indicates the relative variability of the data in relation to the mean. In treatment T1 (Organic Compost), a greater consistency of leaf area is evidenced in all periods of time, followed by T3 (Vermicompost), T4 (Control) and T2 (Manure Fertiliser) in descending order in most cases. There are significant differences at 15 days in T1 vs T2, T1 vs T4, T2 vs T3 and T3 vs T4; while in T1 vs T3 and T2 vs T4 there are no differences. At 30 days, the significant differences are observed in T1 vs T2, T1 vs T4, T2 vs T3, T2 vs T4 and T3 vs T4, in T1 vs T3 there is no difference. Finally, at 45 days the treatments T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T3 and T3 vs T4 have significant differences; the rest T2 vs T4 did not present a difference.

In accordance with the results of the leaf area of the oregano plant, it is visualised that the CV is lower at 15 days (2.97%), this represents a greater consistency among the data of the different

samples. However, at 30 days (8.52%) and 45 days (5.10%), the CV is higher, which shows that there is a greater variability in the data in these periods.
It is noteworthy that organic compost can have a positive impact on the leaf area of oregano plants compared to other treatments, and that the variability in the leaf area can increase over time.

Table 5. Average fresh weight of the plant (g) at 15, 30 and 45 days in the growth of Oregano (Origanum vulgare) with the application of organic fertilisers

TREATMENT	Oregano plant fresh weight (g)		
	15 days	**30 days**	**45 days**
T1 Organic Compost	80,40 a	110, 27a	156,3 a
T2 Manure Fertiliser	70.7 b	85,14 b	121,24 b
T3 Vermicompost	77,9 b	87,13 b	120,23 b
T4 Control	63,3 c	75,13 c	90,24 c
CV (%)	8.60%	13.49	20.20%

Note: T1, T2, T3 and T4 are the evaluated treatments. Means with a common letter are not significantly different (p ≥0.05).
Table 5 shows the results of the evaluation of the fresh weight of oregano plants under different treatments at 15, 30 and 45 days after the start of the experiment. The coefficient of variation (CV) in percentage is also included for each period, which indicates the relative variability of the data in relation to the mean.
In treatment T1 (Organic Compost), the highest fresh weight is presented in all periods of time, followed by T3 (Vermicompost), T4 (Control) and T2 (Manure Fertiliser) in descending order in most cases. Regarding significant differences, it is observed that at 15, 30 and 45 days there are significant differences in T1 vs T2, T1 vs T3, T1 vs T4, T2 vs T4 and T3 vs T4, while in T2 vs T3 there are no significant differences in any of the different periods.
In accordance with the above, the lowest CV is at 15 days (8.60%), this means that there is greater consistency among the data of the different samples. However, at 30 days (13.49%) and 45 days (20.20%), the CV is higher, representing a greater variability in the data in these periods.
It should be noted that, these results demonstrate that organic compost as treatment 1 of oregano plants can generate a positive benefit in the fresh weight of oregano plants compared to other treatments.

3. DISCUSSION

In this study, the effects of the treatments on the investigated variables provided positive responses in the growth of Oregano (Origanum vulgare). Regarding the variables plant height at 15, 30 and 45 days table 1, treatment (1) corresponding to organic compost yielded values of 15.6, 33.5 and 41.8 respectively, higher than those reported by Sevilla (2005) during the early stages of oregano growth, which range between 5.1 cm and 10 cm with manure substrate, and from 7.2 cm to 14.3 cm using only soil. The reduced height of the plants in highlands also reflects an adaptation strategy to avoid the damaging mechanical effect of strong winds at high altitude (Kofidis et al., 2003).
Compared to other substrates, the values are higher than those reported by Reyes et al. (2022). In their work, they mention an oregano height of 32.46 cm with three types of substrates: 1) 100% Soil, 2) mixture of 35% soil, 30% sand, 30% bokashi and 5% lime, 3) 35% soil, 35% rice husk and 30% sand.
According to Puccio (2018); Reyes & Molina (2022) the height of the oregano plant can reach between 30 cm and 90 cm, although the time period or the type of substrate to reach this height is not mentioned. According to the results of this research, it is reflected that the values in the literature are below the range mentioned by the author.
Ramos-González, et al. (2019). Las plantas de albahaca (O. basilicum) cultivadas con lombricomposta (T1) y bocashi (T2), lombricomposta (T1) y Boscashi (T2), obteniendo mayores alturas posteriormente a las podas, en comparación las plantas del T1 y T2 indicaron una respuesta muy variable en su desarrollo. Las ramas obtuvieron en promedio una longitud máxima de 24 cm tanto en las plantas T1 como en la T2.

In relation to the stem length (cm) in the Origanum vulgare plant, a variable growth was observed in the treatments with organic fertilisers (Organic Compost (T1), Manure Fertiliser (T2) and Vermicompost (T3)), as well as in the control (T4) (see Table 3). The treatment that showed the greatest length was T1 (organic compost), with values of 25.3, 35.5 and 42 cm respectively, followed by T3 (Vermicompost) with values of 23.8, 33.5 and 40.3 cm in length. These values are higher than those reported by Ramos-et al. (2019) in their study with oregano (O. vulgare), where both the control and the plants of T1 (Bocashi) and T2 (Vermicompost) reached an average maximum length of branches of 24 cm.

Davidenco, Vega & Argüello (2012) evaluated the photoperiod sensitivity of two traditional subspecies of oregano (compact: Origanum vulgare ssp. vulgare and Criollo: Origanum vulgare ssp. hirtum letsw.) and found that both respond to the increase in photoperiod, reducing the length of their cycle and shortening it under extended photoperiod conditions.

Compared to other substrates and crops, the values are high compared to those reported by, Gálvez et al. (2019). In their work, they made a compost derived from sugar cane (bagasse and vinasse) with 16.5 kg of stubble, 16.5 kg of guinea pig manure, 11 kg of bagasse and 11 litres of vinasse. This consists of 5 treatments with doses T1 with 0, T2 with 10, T3 with 15, T4 with 20 and T5 with 25 g, and determined that T4 stood out with a radish plant length of 25.16 cm.

Leaf Area (cm2)

With respect to the Leaf Area (cm2), it was observed that the treatments that showed a larger leaf area were T1 (organic compost), with values of 4241.13, 5589.26 and 8820.43 cm2 respectively, followed by T3 (Vermicompost) with values of 4147.40; 5373.13 and 8085.31 cm2. These results are similar to those of Morales (2015), who in his research used two production systems in oregano in open field and shade with four doses of Bocashi (0,3,6,9), with values of 7034.76; 8050.77; 10348.10; 12148.25 cm2, yielding a larger leaf area in T4.

As for the fully expanded leaves of oregano, it is observed that they are larger and thicker at medium and high altitudes. Kodifis et al. (2003) found that many plants that grow along an altitudinal gradient have smaller leaves at high elevations.

Compared to other crops and substrates, Torres et al. (2019) made a compost derived from sugar cane (bagasse and vinasse) and determined that T4 has a larger leaf area with 14.53 cm2, in relation to the others.

The fresh weight of a plant(g) is determined by the amount of water and tissue that compose it. In this research, it was observed that organic fertilisers had a considerable impact on the development of oregano. The best performance was obtained with treatment T1 (organic compost, dose of 45 g/m^2), reaching values of 80.40, 110.27 and 156.3 respectively. It was verified that the evaluated compost contributed to the increase of the biomass of the plants, represented in its fresh weight. This was evidenced when comparing it with treatment (4) control, to which no compost was applied, and which resulted in a lower production in relation to the treatments that received the different doses of fertiliser, showing higher values than those reported by Ramos-González et al. (2019).

In their work, Ramos-González et al. (2019) mention two treatments (bocashi and vermicompost) and a control (forest soil). The oregano did not adapt to the proposed production system because its root requires more space. The wet biomass harvested was very low, with a maximum yield of 0.426 kg/m^2, a much lower value than that reported by Burgos et al. (2016), which was from 0.7 to 1.3 kg/m^2 when applying urea at different fertilisation doses on sandy soils in the northwest of Corrientes. Burgos et al. (2016) observed an increase in the total fresh weight yield per hectare by 270%.

Mazzola, Bollini, Picca and Torroba (2016) studied the productive behaviour of four ecotypes of oregano (Criollo, Mendocino, Cordobés and Compacto) in the irrigated area of 25 de mayo. They observed significant differences in production, with the Criollo and Cordobés ecotypes being the best performers, exceeding the average of the producing regions such as Mendoza and Córdoba.

Oregano is a plant that requires dry and sunny climates, and adapts to different types of soils, as long as they have good drainage. The highest water requirements occur when the plant is young and during flowering (Argüello, 2012).

In relation to other substrates, it was observed that organic fertilisers considerably influenced the development of oregano. The best performance was obtained with T1 (island guano 20 tn/ha), reaching 4723.33 kg/ha in fresh matter, followed by T3 (guinea pig fertiliser 20 tn/ha) with 3210 kg/ha, and T2 (cattle fertiliser 20 tn/ha) with 2140 kg/ha. Finally, the yield was very low in T0 (Control) without the application of any type of fertiliser, being this of 1376.67 kg/ha (Estrada, 2020).
According to the dynamics of biomass production, in native populations of O. vulgare, it was observed that as the growing season progresses, the plants grow in height following a common response pattern. However, the maximum values reached vary according to the altitude of the region, being higher at lower altitude (0.55 m at 200 masl and 0.35 m at 1760 masl) (Kodifis et al., 2003; Burgos, Schroeder and Cañete-García, 2016), Mazzola et al. (2016). This highlights the importance of understanding the behaviour of oregano varieties in different areas, as their characteristics can vary according to the environment.
Compared to other crops and substrates, Torres et al. (2019) made a compost derived from sugar cane (bagasse and vinasse) and determined that T4 stood out in yield with 15.39 tn/ha, weight per plant 44.66 g.

CONCLUSION

Organic Compost (T1) proved to be the most effective treatment when wanting to promote the growth of Oregano plants (Origanum vulgare) compared to the other treatments (Manure Fertilizer, Vermicompost and the control group) in relation to height, stem length, leaf area and fresh weight of the plant in all measurements over 15, 30 and 45 days.
Significant differences were obtained between the treatments in all measurements, so it is noteworthy that each type of fertilizer generated a different impact on the growth of Oregano plants (Origanum vulgare), data that is important when wanting to choose the right type of fertilizer to promote the growth of this class of plants.
As the days increase to 15, 30 and 45, an increase in the CV is observed in all measurements, a representative data that allows determining that there is greater variability in the results as time progresses. It should be mentioned that this finding could have been originated by certain factors, such as the natural growth of oregano plants (Origanum vulgare) and/or the influence of other environmental factors.
The results of the yield (fresh weight) of oregano (Origanum vulgare) obtained in this experiment suggest that this crop has the potential to be included in an agricultural diversification plan for small farmers. Although the plant responds adequately to fertilization in the different treatments, it adapts to different types of soils with easy drainage, it is necessary to improve the management of the different ecotypes to increase the crop production.

Considerations and limitations

With the sampling method used, there may be biases in the data collected.

Contribution of the authors

LKPM: Methodological design guidance, discussion and conclusion; YZDT: Results, conclusion, style of work, DMRM: Analysis Theoretical and conceptual review; CPTG: Analysis Theoretical and conceptual review MPRM: Methodological design guidance; LKJR: Analysis and information processing; EJVC: Responsible for writing, style correction and article visualization.

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