ECORFAN Journal Republic of Nicaragua 10[18]1-11: e51018111
Article

The growth exponential of the earthworm red Californian (*Eisenia foetida*) on a substrate of organic waste

Crecimiento exponencial de la lombriz roja Californian (*Eisenia Foetida*) en un sustrato de residuos orgánicos

García-García, Damaris Carmen* [a], Hernández-García, Cintia Elí [b] and Diez-Barroso-Agroz, Allan Ronier[c]

[a] ROR Polytechnic University of the Valley of Mexico • 0009-0004-6255-0670 • 121259
[b] ROR Polytechnic University of the Valley of Mexico • 0009-0005-0574-1830 • 236500
[c] ROR Polytechnic University of the Valley of Mexico • 0009-0000-6986-9482 • 121259

CONAHCYT Classification:

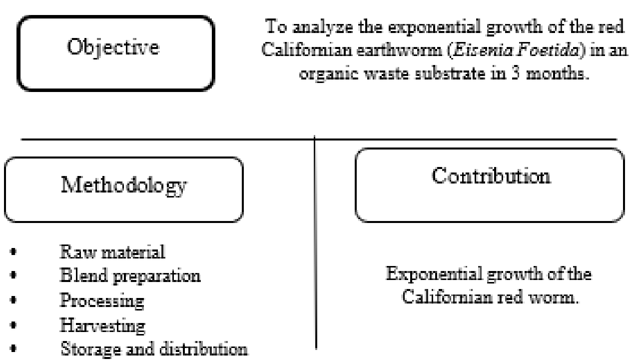
Area: Biotechnology and Agricultural Sciences Field: Agricultural biotechnology
Discipline: Agricultural biotechnology
Subdiscipline: Others

https://doi.org/10.35429/EJRN.2024.10.18.5.11
History of the article:
Received: July 21, 2024
Accepted: December 01, 2024

* ✉ [lizethgarcia076@gmail.com]

Abstract

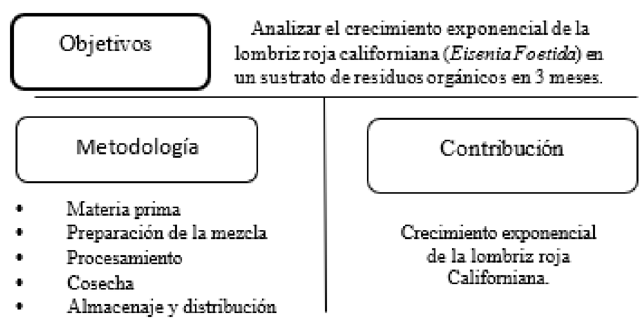
Vermiculture has an ecological approach due to the recycling of the different substrates used in its feeding; it also has a biotechnological approach due to the microbiological and biochemical phenomena that occur in the fermentation process of the worm feeding on organic materials; it also provides a simple, rational and economical response to the environmental problem. The Californian red worm (*Eisenia Foetida*) doubles its population after 3 months; the objective of this project is to record the progress and exponential growth of the Californian red worm as well as its growth rate after these 3 months with a substrate of organic waste.



Vermicompost, exponential growth, Californian red worm

Resumen

La lombricultura tiene un enfoque ecológico debido al reciclado de los diferentes sustratos utilizados en su alimentación; también tiene un enfoque biotecnológico debido a los fenómenos microbiológicos y bioquímicos que se producen en el proceso de fermentación de la lombriz al alimentarse de materiales orgánicos; además proporciona una respuesta sencilla, racional y económica al problema medioambiental. La lombriz roja californiana (Eisenia Foetida) duplica su población al cabo de 3 meses; el objetivo de este proyecto es registrar el progreso y crecimiento exponencial de la lombriz roja californiana así como su tasa de crecimiento al cabo de estos 3 meses con un sustrato de residuos orgánicos.



.
Vermicompost, crecimiento exponencial, lombriz roja californiana

Citation: García-García, Damaris Carmen, Hernández-García, Cintia Elí and Diez-Barroso-Agroz, Allan Ronier. [2024]. Building the future: The growth exponential of the earthworm red Californian (Eisenia foetida) on a substrate of organic waste. ECORFAN Journal Republic of Nicaragua. 10[18]1-11: e51018111.

Introduction

Composting represents a highly beneficial area of opportunity in our country, as it allows reducing the costs of transporting and disposing of waste, with the corresponding risk of contamination and proliferation of harmful fauna, in addition to obtaining a marketable product. Although composting has gained popularity and there are countless manuals and techniques, it is necessary to disseminate this practice among the community to solve the problems of organic waste contamination and offer low-income families a way to earn income, thus contributing to social well-being.

Vermiculture is an agricultural activity and consists of the technical breeding of worms in captivity, the immediate objective of which is the production of worm humus, which is an entirely organic fertilizer, and additionally, a larger quantity of worms, which are called breeding stock or vermicompost biomass, which constitute an important source of protein.

Vermiculture has an ecological approach due to the recycling of the different substrates used in its feeding, and a biotechnological approach due to the microbiological and biochemical phenomena that occur in the fermentation process of the worm when feeding on organic materials, in addition to providing a simple, rational and economic response to the environmental problem. Vermiculture is a growing business and will in the future be the fastest and most effective means of soil recovery in rural areas.

The California red worm (Eisenia Foetida), originally from Eucrasia, has been intensively bred since the 1950s in California (USA) and is used on more than 80% of the world's farms, making it the most widely cultivated species in the world due to its hardiness, tolerance to environmental factors, reproductive potential and capacity for crowding.

The focus of this project will be on the calculation of the exponential growth of the Californian red worm (Eisenia Foetida) in vermicompost having as its main food organic waste, the duration of this project will be estimated at 3 months, since the Californian red worm after this time doubles its population.

This exponential calculation is essential since by having a constant growth rate after this time it is possible to accurately calculate the exponential growth in a given time, whether in days, months or years without the need to manually count the Californian red worms.

Background

Vermiculture as a technique has its origins in 1936 in Los Angeles, USA, with Dr. Tomas Barret. In 1758 Carl von Linnaeus implemented the “Natural System”, which included for the first time a species of earthworm, Lombricus terrestris.

According to Compagnoni, worm farming was born and developed in North America with Hugh Carter in 1947, and then spread to Europe, Asia and America. In 1988, thanks to some research, another species of earthworm was found, superior to the traditional one, the *Eisenia Foetida* . (Rodríguez, 1996)

Concept of vermiculture

Vermiculture is a biotechnology that uses domesticated earthworms (Eisenia foetida) as work tools. Under certain conditions (temperature, humidity, pH), various organic materials can be recycled and used to produce humus and worm meat as a final product. This technology has applications in agriculture with production systems that require recycling solid waste into high-quality organic fertilizers, which generates economic benefits, and worm biomass that can be used to feed birds, fish and pigs. (Heras Sierra, 2015)

Vermicomposting process

Raw material

A wide variety of organic waste can be used, however, it is more feasible to use pre-consumer waste of plant origin (vegetable peels), excluding citrus fruits because their acidity conditions affect the worm population. Preparation of the mixture.

Necessary preparations for materials to be added to vermicomposting include particle size reduction of waste, mixing, moisture control, and inoculation with live strains of microorganisms and worm castings.

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

Vermicompost producers recommend feeding worms with partially decomposed materials, to avoid excessive heat production when organic matter accumulates and decomposes due to its high carbon content, although practice has shown that worms can be fed with "fresh" waste when a correct carbon/nitrogen ratio is sought and animal waste (meat, fish and seafood, poultry and dairy) is avoided.

Inoculation: It is advisable to inoculate the container with mature vermicompost and worms of the *Eisenia Foetida species* (Californian red worm).

Harvest

It is generally suggested to harvest vermicompost six months after the system has been in operation, when the contents have acquired a dark brown colour. The worm moves to the upper layers of the container through a mesh, while the compost remains at the bottom.

Californian red worm (Eisenia foetida)

The red worm (RW) is commercially known by the nickname "Californian" because it was in this US state where the first intensive worm farms were developed in the 1950s. The reproduction of worms in captivity treated with bovine manure compost has produced the highest breeding values (expressed as number of offspring at 14 and 21 days and total offspring per cocoon). This type of feeding was the most efficient at all times of the year, increasing its value even more in spring and summer (Toccalino et al., 2004)

Box 1

Table 1

External morphological characteristics of the earthworm Eisenia foetida (EF). (The numbers indicate the number of segments in which each of the characters is found)

Character	Eisenia foetida
Color	Wine red in colour. Orange or yellow stripes at the end of the body.
Shape	Slightly flattened dorsoventrally.
Quetas	Lumbricin.
Length (cm)	6-9
Number of segments	96-118
Weight (g)	0.3-1
Clitellus	[26-33]
Male pores	15-With papillae. Globose shape. 1 pair in the shape of an eyelet.
Female pores	14. 1 lateroventral pair.

Source: (Melendez Gomez, 2003)

Factors to consider when planting Californian red worm

- **Location:** They can be placed in shaded areas such as pergolas, under trees that do not have tannin, moss, galleries, ecological boxes and in open fields, placing high layers of grass for protection, thus avoiding evaporation and allowing easy access.

The surface must be almost flat, not have a slope greater than 20% and not be exposed to flooding. Drainage ditches must be made with very good water availability. It is necessary to orient the beds in the same direction as the prevailing winds.

- **Lighting:** Earthworms are very sensitive to ultraviolet rays, which can cause their death. It is therefore advisable to place them in shaded or covered areas.

- **Humidity:** This is one of the most influential elements. Errors, whether due to a lack or excess, have negative consequences for the production of humus as well as for the reproduction and fertility of the worm. Humidity should be maintained between 75% and 80%, since humidity levels below 70% are unfavorable for breeding and levels below 55% are death levels.

- **Temperature:** The ideal temperature is between 15-24ºC, as close as possible to the body temperature of the worm, which is 19ºC. Above

30ºC the worm can withstand the temperature well, but at the cost of lower production and a decrease in humus production.

- **pH:** A determining factor for good vermiculture is to have a pH between 6.5 and 7.5 and the optimal values are between 6.8 and 7.2. (Fuentes Yague, 1987).

- **Aeration**: Earthworms require air for their vital process and therefore it is necessary to remove the beds with a rake at least every seven days. (Somarriba Reyes & Guzmán Guillén, 2004).

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

Exponential growth

Exponential growth (EG) describes a hypothetical model of population growth in which space and resources are available in an unlimited manner.

As a result, the rate of population growth increases with each new generation.

According to this model, a population grows rapidly and continues to grow indefinitely.

There are two different types of exponential growth:

Discrete Growth: is modeled with:

$$y_t = y_0(1+k)^t \quad [1]$$

Where growth occurs at specific intervals.

Continuous Growth: It is modeled with:

$$y = y_0 e^{kt} \quad [2]$$

Where growth is continuous over time.

Both formulas are essential in different contexts and allow to adequately model the behavior of variables that grow exponentially, either in discrete intervals or continuously.

Regarding this project to calculate the exponential growth of the earthworm population we will be using the continuous exponential growth formula since this formula is used to model situations in which the population grows continuously and at a constant rate, which is characteristic of exponential growth.

In the first instance it must be assumed that:

$t =$ time (days)
$t = 1$ $(\emptyset)$ initial value
$t_0 = 0$
$y =$ population
$k =$ growth rate
In an equation it would look like this:

$$y = f(t)$$

But we need to focus the equation on the population that varies with respect to time giving the following equation:

$$\Delta y = \Delta t$$

Every increase in time increases the population.

The population change will be the population multiplied by the increase in time.

Population growth is the number of inhabitants in time X multiplied by the temporary increase, but it must grow with respect to the growth rate.

$$\Delta y = ky\Delta t$$

It is written as follows:

$$\frac{\Delta y}{\Delta t} = ky$$

Therefore, this expression also passes in its differential form:

$$\frac{dy}{dt} = ky$$

This equation must be integrated, but you can't have two differentials on one side, so it separates as it was originally:

$$dy = ky\, dt$$

The variable y must be changed to the other side:

$$\int \frac{dy}{y} = \int k\, dt$$

Once we have the expression, we integrate it.

According to the integration formulas, when integrating the

$\frac{dy}{y}$ is equal to $\ln y$:

$$\ln y = \int k\ dt$$

The k is a constant, so only dt is integrated:

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

$\ln y = kt + c$

Since this is an explicit problem, it is assumed that *c is:*

Yeah

$y = y_0$
$t = t_0 = 0$

Replacing :

$$\ln y_0 = k(0) + c \quad \rightarrow \quad c = \ln y_0$$

Substitute *c* in the solved integral:

$\ln y = kt + \ln y_0$

The value of *y* remains as is and may change from one day to the next.

$y_0 =$ poblacion inicial

$\ln y = kt + \ln y_0$

The two are joined Inby only one side:

$\ln y - \ln y_0 = kt$

By the law of logarithms the subtraction of two

Inis $[\ln a - \ln b = \ln(\frac{a}{b})]$:

$$\ln \frac{y}{y_0} = kt$$

What is needed is clarification $y$to calculate the population.

He Ingoes over to the other side as his opposite:

$$\frac{y}{y_0} = e^{kt}$$

Cleaning y_0:
$y = y_0 e^{kt}$

Mathematical expression that describes exponential population growth.

It is used for both exponential growth and exponential decay.

Calculation of the growth rate

The growth rate (GR) is the index that indicates the growth or decrease in the population amount during a specific period.

You will use the discrete exponential growth equation, which is used when growth increments occur at discrete intervals (e.g., annually, monthly, etc.), rather than continuously.

The discrete exponential growth formula $y_t = y_0(1+k)^t$is derived from the idea of applying a constant growth rate over discrete time intervals. Here is a step-by-step explanation of how this formula is derived:

$\ln y = kt + \ln y_0$

Definition of discrete growth:

The quantity y is assumed to grow at a constant rate at discrete intervals. $k$at discrete intervals. That is, after each period, the quantity grows by a percentage of its previous value. $k$percentage of its previous value.

In a first period, the initial amount $y_0$increases according to the growth rate k. The new value
y_1 will be:

$$y_1 = y_0 + y_0 \cdot k = y_0(1+k)$$

In the second period, the new value y_1 grows again at the same rate k:

$$\begin{aligned} y_2 = y_1 + y_1 \cdot k &= y_1(1+k) \\ &= y_0(1+k)(1+k) \\ &= y_0(1+k)^2 \end{aligned}$$

Following the same pattern, after the third period, the value will be:

$$\begin{aligned} y_3 = y_2 + y_2 \cdot k &= y_2(1+k) \\ &= y_0(1+k)^2(1+k) \\ &= y_0(1+k)^3 \end{aligned}$$

This period is repeated for any number of periods. t Generalizing, after t the periods, the value will be:

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

$y_t = y_0(1+k)^t$

From the discrete exponential growth formula we will clarify k.

Where:

y_t = final population
y_0 = initial population
t = time

Compensation k for calculating the growth rate:

We go $y_0$to the other side of the operation, we multiply by what happens when we divide:

$$\frac{y_t}{y_0} = (1+k)^t$$

The same is done with the exponential $t$since in exponential it goes to the other side as a radical:

$$\sqrt[t]{\frac{y_t}{y_0}}$$

The 1 is added and subtracted as it is added, obtaining:

$$\sqrt[t]{\frac{y_t}{y_0}} - 1 = k$$

By the law of radicals we know that $\sqrt[n]{a^m} = a^{m/n}$we can observe the formula as follows:

$$(y_t/y_0)^{\frac{1}{t}} - 1 = k$$

Adjusting the equation we obtain:

$$k = (y_t/y_0)^{\frac{1}{t}} - 1$$

If k is positive, the population grows.
If k is negative, the population decreases.

In any case, population variation can be expressed as a function of the growth rate, that is, the percentage variation:

$$\text{Razón del crecimiento} = \text{Tasa de crecimiento} \times 100$$

In cases where the growth rate is zero, we are talking about a population in equilibrium: the population is neither increasing nor decreasing. This means that the birth and death rates are equal.

Methodology

General steps for establishing a vermicompost plantation

Preparing the vermicomposting box

Using the drill, a hole was made on one side with a diameter of 2 cm, this hole was made with a 16 mm drill bit, this hole is to place the ½ inch bit wrench.

This key will be in the lower center of the box, so that the leachate exits through here. The key was installed in the box and reinforced with hot silicone to prevent leaks and keep it in place (Fig. 1).

Box 2

Figure 1
Perforated plastic box for vermicompost with a pointed key already fitted
Source: Own elaboration

Inside the box and to collect even more leachate, there will be a ½ inch female adapter, around this female adapter there will be a mesh cloth, to prevent the worms from exiting through the faucet (Fig. 2).

Box 3

Figure 2
Perforated plastic box for worm composter with a ½ inch female adapter and a 1/2 inch male key on the inside of the box, with 0.5 cm perforations on the sides
Source: Own elaboration

Eight holes with a diameter of 0.5 cm were drilled separately on the sides of the box, which will serve as ventilation for the box (Fig. 3).

Box 4

Figure 3
Perforated plastic box for worm composter with a ½ inch female adapter and a 1/2 inch male key on the inside of the box, with 0.5 cm perforations on the sides
Source: Own elaboration

To prevent the worms from escaping through the 0.5 cm holes on the sides, a cloth mesh was placed over the holes. Rectangles of mesh measuring 8.5 x 6 cm were cut and glued with hot silicone for better adhesion (Fig. 3).

Box 5

Figure 4
Vermicompost box with the first layer of substrate (dry leaves and branches)
Source: Own elaboration

Layer 1. Dry leaves and branches as a substrate for vermicompost

Dry leaves and branches were chosen as the main substrate for the vermicompost, since this allows the soil to aerate. In this first layer it only occupied 5 g and had a height of 1 cm (Fig. 4).

Layer 2. Composted soil

As a second layer, previously composted soil was placed on the vermicompost to speed up the vermicomposting process a little; 1 kg was added and the vermicompost had a height of 2 cm (Fig. 5).

Box 6

Figure 5
Vermicompost box with the second layer, composted soil
Source: Own elaboration

Layer 3. Sowing Californian red worms in the vermicompost

In this third layer the worms were added, there will be a total of 6 Californian red worms, one of the worms still has its clitellum developing (Fig. 6), the lake of each of the worms will be described below.

Box 7

Figure 6
Image of the 6 Californian red worms that will be in the vermicompost
Source: Own elaboration

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

Layer 4. Organic waste

For the fourth layer, organic waste should preferably be cut into cubes smaller than 2 cm to increase the speed of waste decomposition, allowing the worms to perform efficient processing, which on this occasion will be administered, watermelon, lettuce and tomato, adding 45 g to the vermicompost (Fig. 7).

Box 8

Figure 7
Vermicompost box with the fourth layer, organic waste

Source: Own elaboration

Layer 5. Crushed eggshell

In this fifth layer, crushed eggshell is essential since it is an excellent fertilizer and controller of soil pH. It should preferably be crushed to better take advantage of its benefits. In this case, 12 g of eggshell were added (Fig. 8).

Box 9

Figure 8
Vermicompost box with the fifth layer, crushed eggshells

Source: Own elaboration

Layer 6. Dry leaves

As a sixth and final layer, dry leaves will help prevent excess moisture and allow better aeration. In this layer, the dry leaves will be smaller and slightly crushed. 5 g were added to the vermicompost with a height of 1 cm (Fig. 9).

Box 10

Figure 9
Vermicompost box with sixth layer, plus crushed dry leaves

Source: Own elaboration

Finished vermicompost

Final height: 4.5 cm.
Final weight: 2.2 kg (Fig. 10

Box 11

Figure 10
Vermicompost box on scale with all layers already completed

Source: Own elaboration

During these three months you will have a large cloth bag, since the worm humus must be in a dark place, and the bag will also allow better aeration.

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

García-García, Damaris Carmen, Hernández-García, Cintia Elí and Diez-Barroso-Agroz, Allan Ronier. [2024]. Building the future: The growth exponential of the earthworm red Californian (Eisenia foetida) on a substrate of organic waste. ECORFAN Journal Republic of Nicaragua. 10[18]1-11: e51018111.
https://doi.org/10.35429/EJRN.2024.10.18.5.11

As a final point, the vermicomposting box should be at an inclination of approximately 30°, since with vermicomposting some of its final products are humus and leachate, the leached liquid should not remain stagnant at the bottom of the box, so the inclination helps to better drain this leachate (Fig. 11).

Box 12

Figure 11
Finished vermicompost box with a cloth bag covering it

Source: Own elaboration

Results

Worms were counted manually to trace growth and obtain a growth rate.

Below are the graphs with the results obtained in 100 days.

Box 13

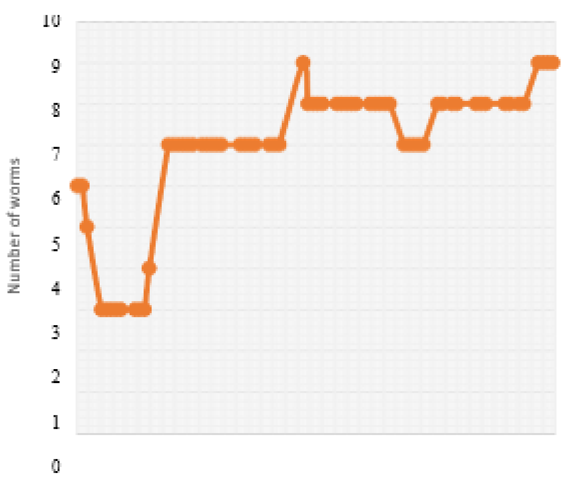


Figure 12
Graph of the exponential growth of the Californian red worm over a period of 100 days

Source: Own elaboration

Box 14

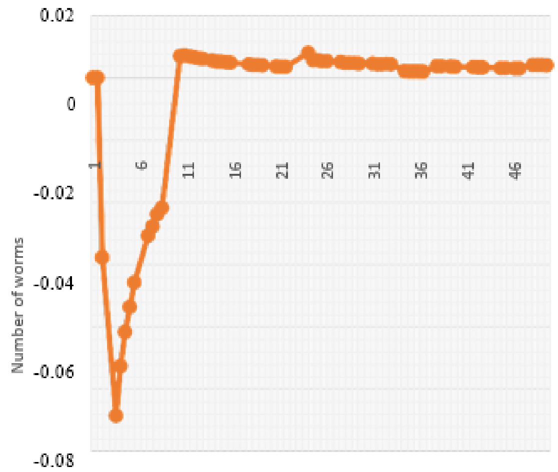


Figure 13
Graph showing the growth rate of the California red worm over a period of 100 days

Source: Own elaboration

The growth rate data was obtained using the unclouded formula of discrete exponential growth. As the days passed, the growth rate remained constant at 0.004.
Having already 100 days of growth, the growth rate can be concluded as:

$k = 0.004$
Growth rate = 0.4%.

This explains why the growth of the Californian red worm increases by 0.4% in 100 days. The formula for continuous exponential growth

$y = y_0 e^{kt}$applies to future dates:
Data:
$y_0 =$ 6 worms
$k = 0.004$
$t =$ years

Box 15

Tabla 2
Exponential growth of the California red worm over the year

Years	Number of worms
1	25
2	111
3	479
4	2062
5	8881
6	38244
7	164680
8	709105
9	3053379
10	**13147727**

Source: Own elaboration

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

García-García, Damaris Carmen, Hernández-García, Cintia Elí and Diez-Barroso-Agroz, Allan Ronier. [2024]. Building the future: The growth exponential of the earthworm red Californian (Eisenia foetida) on a substrate of organic waste. ECORFAN Journal Republic of Nicaragua. 10[18]1-11: e51018111.
https://doi.org/10.35429/EJRN.2024.10.18.5.11

Getting this graph:

Box 16

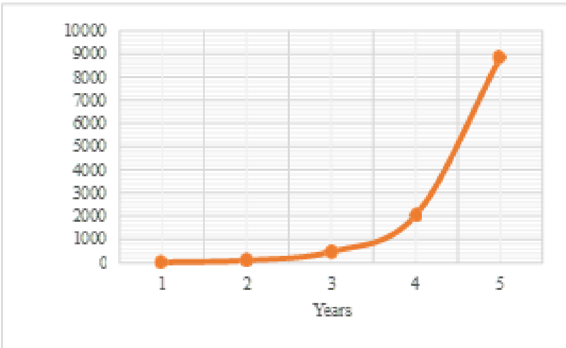


Figure 14
Exponential growth of the California red worm in the first 5 years

Source: Own elaboration

Box 17

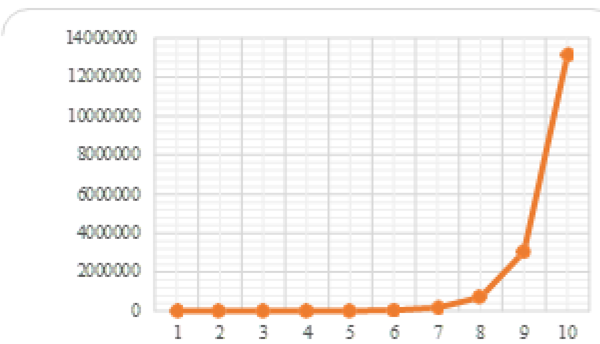


Figure 15
Exponential growth of the California red worm in the 10 years

Source: Own elaboration

Conclusions

The project did not start in the best way, since days after having started the project, unfortunately of the 6 worms that were initially there, 3 worms died, so there are only 3 worms left in the project, it is estimated that it was due to the lack of humidity, in question that the growth rate remained in negative numbers for 13 days, exactly from day 3 to day 20, which was the day that when checking the vermicompost box there were new worms.

California red worms had improved reproduction starting on day 20 of the project, and then had slow reproduction, with one or two new worms approximately every month; growth remained linear in March.

Later, exactly in the first days of March, the population of the 3 worms that resided increased to 7 worms, giving a growth rate of 0.007 for the 20th day. From this day on, the population has remained stable. There are deaths of worms whose cause is unknown, but the population is constantly recovering.

As the days go by, the growth rate decreases only by tenths, but as the days go by, this growth rate does not vary by tenths, it remains constant, so it could be considered that the growth rate can be the constant that at the end of the project can be used to calculate the exponential growth of the Californian red worms over several days, months or years, and give exactly how many worms there will be in the time that is desired to know, without having to count the worms manually.

At first there was no knowledge on the subject so this affected the project at the beginning, if the project could be repeated with what had already been learned there would surely be no negative numbers in the growth rate.

Declarations

Incompatibility

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Author's contribution

Garcia-Garcia, Dámaris Carmen: I contributed to the start of the project, giving the first initiative to work with the Californian red worm.

Hernandez-Garcia, Cintia Elí: I contributed to the monitoring of the project, in addition to being an advisor and trainer for the project.

Diez-Barroso-Agraz, Allan Ronier: I contributed to the financing of the project as well as providing the contractor to contribute to this project.

Garcia-Alvarado, Lizeth: I contributed to the writing of the article and to the realization of the project together with the authors.

ISSN: 2414-8830.
RENIECYT-CONAHCYT: 1702902

Funds

Box 18

Tabla 3

Quotation of materials used in the project

Material	Price	Cost	Shipment
Box	$200.00	$124.00	
Plastic tip wrench	$50.00	$33.50	
½ inch female adapter		$6.50	
Drill	$500.00	$462.00	
Moisture meter	$160.00	$153.82	
Distilled water	$140.00	$115.00	$91.00
Beaker	$200.00	$196.00	$79.00
Mixing spoon	$225.00	$128.00	$79.00
pH meter	$250.00	$237.00	$99.00
Total	**$1725.00**	**$1724.82**	

Source: Own elaboration

Expressions of gratitude

We would like to thank IntGen Technologies de México SA de CV for their financial contribution to the project.

Abbreviations

RW	Red Worm
USA	USA
IS	Eisenia foetida
GRAM	Growth rate
E.G	Exponential growth

References

Background

Fuentes Yague, JL (1987). Breeding the red worm. Breeding the *red worm* , *1* , 28.

Toccalino, PA, Agüero, MC, Serebrinsky, CA, & Roux, JP (2004). Reproductive behavior of the Californian red worm (Eisenia foetida) according to the time of year and the type of food. *Revista Veterinaria*, *2004, vol. 15, no. 2 , pp. 65-69.*

A. Hernández, J., L. Rincón, M., & N. Jiménez, R. (1997). Behavior of the red worm (Eiseniafoetida) under warm climate conditions. 14(4).

Fundamentals

Somarriba Reyes, RJ and Guzmán Guillén, F. (2004). *Vermiculture Guide* . *Technical Guide* (4), 20.

Heras Sierra, S. de J. (2015). *Compost production and reproduction of Eisenia foetida to obtain worm flour from manure of different animal species* [Autonomous University of Sinaloa].

Rodríguez, A. R. (1996). Production and quality of organic fertilizer using the Californian red worm (Eisenia foetida) and its reproductive capacity. *Technical report of the Honduran Coffee Institute IHCAFE.*

Differences

Meléndez Gómez, M. (2003). *Morphology of two species of earthworms: Eisenia foetida and Eudrilus eugeniae.*

Discussions

Nieto Garibay, A., Murillo Amador, B., Troyo Dieguez, E., Beltran Morales, A., Ruiz Espinoza, F.H.,&García Hernández, JL (2010). Utilization of organic waste of animal, plant and domestic origin for the production and use of compost in organic agriculture. organic agriculture