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Carbon Sequestration in the Soil by Means of Two Organic Fertilizers in the Guava Agrosystem

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Abstract: The hypothesis raised was that compost and manure increase carbon sequestration in the soil. Therefore, in order to estimate the capture of CO in the soil, the investigation was carried out in the orchards: Mesa del Marqués, Mesa Sembrada and Los Cerritos, the treatments applied are: control (without the application of fertilizers), 3% compost, 3% bovine manure, 5% Compost and 5% of bovine manure, under a completely random design, with three replications. The % MO, was multiplied by the factor 0.58 obtaining %CO. The soil weight (ton, ha^{-1}) was estimated and by the formula: $tCha^{-1}$ = PS x %CO/100, carbon stocks were estimated in the soil. In Mesa del Marqués, with 5% compost, the catch was 44.79 tC/ha and with 5% of manure of 38.6 tC/ha. In Mesa Sembrada, with 3% of compost was captured 42.4 tC/ha; with 5% of compost the catch was 151.07 tc/ha, and with 5% of manure the catch was 90.53 tc/ha. In Los Cerritos, with 5% of compost, 42.80 tC/ha was captured and with 5% of manure, 19.09 tC/ha. Compost and manure in the percentages used increased carbon sequestration in the soil.

Key words: organic fertilizers, organic carbon, soil, agro system guava

1. Introduction

Global warming is a consequence of the increase in the atmosphere of greenhouse gases, among which are: carbon dioxide (CO_2), which is responsible for 71.5% of the greenhouse effect [1], methane (CH4), nitrous oxide (N_2O), Sulphur dioxide (SO_2), chlorofluorocarbons (CFC), ozone (O_3) and water vapour [2].

These gases (GHG) absorb more than 90% of the infrared radiation that is emitted from the earth. As a result, heat is trapped in the atmosphere allowing a surface temperature of 15°C. Without these greenhouse gases, the average temperature would be -18°C [3].

The concentration of CO_2 in the atmosphere has increased from 280 ppm in the year 1750, to 379 ppm in the 2004, and continues to increase at an annual rate greater than 1 ppm.

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Given the concern about the constant increase in CO_2, different strategies have been implemented to capture the carbon; one of them includes the fixation of CO_2 by the plants that use it in the photosynthesis process and convert it into dry matter [4].

It is feasible to reduce the concentration of CO_2 in the atmosphere and to contribute significantly to the reduction of global warming [5], by protecting and conserving tree and shrub ecosystems, as well as through reforestation and Restoration of degraded ecosystems [6].

In Mexico, research in organic carbon is oriented to its quantification in aerial biomass, and little is known about soil accumulation. The purpose of the research was to estimate the capture of organic carbon (CO) in the soil in response to two organic fertilizers. The application of organic fertilizers favors the capture of C in the soil [7]. CO is the main component of organic matter, which plays an important role in fertility, [8]. Soil CO occupies 69.8% of organic biosphere C [9]. It also affects the chemical and biological physical properties associated with its quality [10], Sustainability [11] and productive Capacity [12], so it must be maintained and preferably increased. The effect of carbon on soil quality was reflected in the modification of the structure, the depth of the roots, the availability of water, the biodiversity and the reserves of nutritive elements [13]. There is little information to establish a clear dependency relationship between SOC and its productivity [14]. The loss of humus in agricultural soils is higher than the rate of formation, so it is a source of CO_2 for the atmosphere [15]. Aggregates contribute to the recycling of carbon [16], are useful to explain differences in the content of organic matter in soils with different management [17], and are an indicator of the potential of carbon sequestration in Edafosistemas Sustainable as guava [18].

Probably found little to discover about the biological fundamentals of the process and the interaction with physicochemical conditions, but much remains to investigate the performance, benefit and effects of the use of organic fertilizers on the ground. Also the correct way to recycle certain waste [19].

The research addresses the problem of the management of organic waste produced in guava orchards and is oriented to find alternatives that decrease the ecological impact [20].

Recycling can reduce the polluting effect that these wastes cause to the environment and allow their reuse as inputs in agriculture. The addition to the soil of biodegradable materials leads to the synthesis of organic complexes that unite the mineral particles in aggregates, increases the porous space, improves the infiltration and storage of water [21].

In the research, the objective of estimating the accumulated organic carbon in the soil in response to different percentages and sources of organic matter was raised.

2. Materials and Methods

The Guayabera region in the state of Aguascalientes is located in the municipality of Calvillo and its geographical location in the parallels 22°07' and 21°42' of north latitude and the meridians 102°31' and 102°53' of longitude West, at an altitude between 1500 and 2900 M [22].

Table 1 Geographical location of the orchards where the research was conducted.

Orchard	Place	Paralel (LN)	Meridians (LW)	Altitude, m
M. Marqués	Tepetate	21º 46'	102° 45'	1752
M. Sembrada	San Tadeo	21º 55'	102º 40'	1831
Los Cerritos	The Baker	21º 51'	102º 42'	1169

Table 2 Description of the orchards where the research was carried out.

Description	**Mesa del Marques**	**Mesa Sembrada**	**Los Cerritos**
Producer	Simón Mercado	Silverio Trinidad	Alejandro de Loera
Year of trial	2012-2013	2012-2013	2012-2013
Locality	Tepetate de abajo	San Tadeo	La Panadera
Coordinates	21° 46 N y 102° 45 W	21° 55 N y 102° 40 W	21° 51 N y 102° 42 W
Altitude	1752 m	1831 m	1169 m
Variety	Media China	Media China	Media China
Give. Planting	7 m × 6 m	6.5 m × 6.5 m	4 m × 4 m
Den. de plantación	328 trees by Ha.	237 trees by ha	625 trees by ha
system Weekly	Weekly	10 days	15 days
Proc. Of the water	Grounds	Grounds	Grounds
Pruning	Severe	Sprouting	Sprouting
Fertilización	Triple 17	Triple 17	Triple 17
Pest Combat	Malathión	Malathión	Malathión
Weeding	Machining	Machining	Machining

Climate: The climate in the Guayabera region of Calvillo, is distributed in the following way. Semi-dry-tempered 35.4%; Semi-dry semi-warm 33.4%; Temperate sub-humid with rains in summer of less humidity 29.5%; Temperate sub-humid with rains in summer of average humidity 1.7%

Calvillo floors: Nine orders are reported: Phaeozem (31.1%), Leptosol (26.1%), Regosol (18.2%), Luvisol (7.9%), Calcisol (5.0%), Planosol (2.9%), Cambisol (2.9%), eutric (2.9%), Castañozem (2.1%), (INEGI 2005).

The common characteristics of the trees: in the orchards studied are: Variety "Chinese Media", population density 200/ha. trees, sprinkler irrigation system, one irrigation per week, fertilization with the formula Triple 17, pruning plucking, pest combat (malathion), weeding machining.

Treatments: The treatments studied were: control (without application of fertiliser), 3% of compost (9 kg/m^2), 3% of manure (4.41 kg/m^2), 5% of compost (15 kg/m^2) and 5% of manure (7.35 kg/m^2).

Edaphic variables evaluated: In the three orchards under study, variables were evaluated: percentage MO, as well as percentage CO by calcination and TC/ha. Soil carbon was calculated from the percentage of organic carbon (% CO), apparent soil density (Da = g/cm^3) and sampling depth (m). The weight of the soil per hectare was estimated and this value was multiplied by the percentage of carbon obtained in the analysis of the samples and was divided by one hundred, obtaining the values in tC ha^{-1}. The analysis of variance was performed for each variable and mean comparison tests using the Tukey test, 0.05 where statistical significance was found.

3. Results and Discussion

In Table 3, it is observed that the percentage MO, percentage CO and quantity of carbon in the soil (tC/ha) varied with the fertilisers and with the doses (Tukey, 0.05). With 3% compost and manure on average showed the same effect and with 5% compost exceeded manure. The result was similar with the increase of CO in the soil, due to the direct relation of these two variables. The magnitude of the response in carbon sequestration was 5% compost 44.79 tC/ha and 5% manure 38.6 tC/ha.

In the Orchard Mesa sown (Table 4) also found response of organic fertilizers in the increase of % MO, % CO and amount of carbon (tC/ha), (Tukey, 0.05). The higher values correspond to the higher percentages for both compost and manure.

In the orchard Los Cerritos (Table 5), compost and manure response is also appreciated, although the results are more modest. The increase in % MO and % CO evaluated in the three orchards, coincides with the indicated by Eghball and Power, 1994, by Sing et al 1995 and Tester, 1975, who concluded that the application of organic amendments such as manure or compost leads to an increase in organic carbon of soil varying between 22 and 50% compared to the original levels.

Table 3 Content of MO, CO and cuantity of carbon in the Orchard Mesa del Marqués.

Treatments	% MO		% CO		tC/ha	
	Evaluated	Effect	Evaluated	Effect	Evaluated	Effect
Witness	13.35 b		7.74 b		186.94 bc	
3% Compost	15.14 ab	1.79	8.78 ab	1.04	180.19 c	
3% Manure	14.03 ab	0.68	8.14 ab	0.40	186.02 bc	
5% Compost	17.02 a	3.67	9.87 a	2.13	231.73 a	44.79
5% Manure	16.31 ab	2.96	9.57 ab	1.83	225.54 ab	38.60

% MO = Percentage of organic matter, % CO = Percentage of organic carbon, tC/ha = tones of carbon per hectare. The stockings that do not share a letter are significantly different.

Table 4 Content of MO, CO and quantity of carbon in the Orchard table sown.

Treatments	%MO		%CO		tC/ha	
	Evaluated	Effect	Evaluated	Effect	Evaluated	Effect
Witness	16.52 b		9.59 b		195.35 b	
3% Compost	19.25 ab	2.73	11.16 ab	1.57	237.75 ab	42.4
3% Manure	18.49 b	1.97	10.73 ab	1.14	199.21 b	3.86
5% Compost	20.12 a	3.6	11.67 a	2.08	346.42 a	151.07
5% Manure	18.81 ab	2.29	10.91 ab	1.32	285.88 ab	90.53

% MO = Percentage of organic matter, % CO = Percentage of organic carbon, tC/ha = tones of carbon per hectare. The stockings that do not share a letter are significantly different.

Table 5 Content of MO, CO and quantity of carbon in the orchard Los Cerritos.

Treatments	%MO		%CO		tC/ha	
	Evaluated	Effect	Evaluated	Effect	Evaluated	Effect
Witness	10.08 b		5.85 c		140.57 a	
3% Compost	12.71 ab	2.63	7.37 b	1.52	144.75 a	4.18
3% Manure	10.41 b	0.33	6.04 c	0.19	135.84 a	-4.73
5% Compost	15.13 a	5.05	8.78 a	2.93	183.37 a	42.80
5% Manure	11.35 b	1.27	6.58 bc	0.73	159.66 a	19.09

The averages that do not share a letter are significantly different.

4. Conclusions

The objective of estimating the response in the increment of MO, CO and carbon sequestration in the soil (tC/ha) in response to the application of compost and manure in doses of 3% and 5% was fulfilled.

The results indicate that the organic matter increased with 5% of compost in magnitudes of 73.4, 72.0 and 101 ton/ha and with 5% of manure, the increases were; 59.2, 45.8 and 25.4 ton/ha.

In carbon, with 5% of compost, the increase was 42.6, 41.6 and 58.6 ton/ha, and with 5% of manure of 36.6, 26.4 and 14.6 ton/ha.

The capture of C with 5% of compost was 44.79, 151.07 and 42.80 tc/ha and with 5% of manure in 38.6, 90.53 and 19.09 tC/ha.

The results suggest that compost and manure capture significant amounts of atmospheric carbon, which means that it contributes to the reduction of CO_2 levels in the atmosphere and thus achieved an important environmental service.

The results show the usefulness of compost, so it is recommended plant-level recycling, of organic waste by composting and its application to trees as organic fertilizer.

In future research, it is suggested to evaluate the impact of compost and manure on the physical-chemical and biological variation in relation to soil productivity.

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