Article

Chemical and organic fertilization in the production of watermelon in northern Mexico

Tomás Juan Álvaro Cervantes Vázquez[1]
Manuel Fortis Hernández[2]
Héctor Idilio Trejo Escareño[1]
Cirilo Vázquez Vázquez[1§]
Miguel Ángel Gallegos Robles[1]
José Luis García Hernández[1]

[1]Faculty of Agriculture and Zootechnics-Juarez University of the State of Durango. Highway Gómez Palacio-Tlahualilo km 35, Gómez Palacio, Durango. Mexico. CP 35000. Tel 01 (871) 7118918. (alvaro87tomas@hotmail.com; idilio72@yahoo.com.mx; garoma64@hotmail.com; luis-garher@hotmail.com). [2]Technological Institute of Torreón. Highway Torreón-San Pedro km 7.5, Ejido Ana, Torreón, Coahuila, Mexico. CP. 27170. Tel. 01(871) 7507198, 7507199. (mforty05@yahoo.com.mx).

[§]Corresponding author: cirvaz60@hotmail.com.

Abstract

In the present study, the effect of fertilization with solarized bovine manure and vermicompost at different levels in the watermelon crop variety PEACOCK WR124 was evaluated. A watering system was used. The study factors were bovine manure (FE) and vermicompost (FV) at different levels. In the case of FE: 0, 40, 60, 80 t ha^{-1}, chemical fertilization (FQ) 120-60 and for FV: 0, 3, 6, 9 t ha^{-1}. An experimental block design was used randomly with arrangement in stripes with three repetitions. The soil variables studied were: electrical conductivity, pH, organic matter and nitrates at three depths (0 to 15, 15 to 30 and 30 to 45 cm). The yield and total soluble solids in fruit were evaluated. The highest values of organic matter (3.23%) and nitrates (39.71 mg kg^{-1}) were found in the depth from 0 to 15 cm, corresponding to the treatment of 80 t ha^{-1} of solarized bovine manure and 9 t ha^{-1} of vermicompost, showing an increase due to the interaction of organic fertilizers. Significant statistical difference was found in CE and soil pH. The best yields were associated with the treatment of vermicompost of 3 t ha^{-1} with the chemical treatment, with a yield of 32 t ha^{-1}.

Keywords: *Citrullus lanatus* L., solarized manure, watering by strip, vermicompost.

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Introduction

The Comarca Lagunera is located in the limits of Coahuila and Durango, states of northern Mexico. This region is characterized by having a strong economic activity based on agricultural production, mainly the production of milk and its derivatives. In the region, there are more than 500 000 heads of dairy cattle. This results in a generation of more than 1 200 000 t year^{-1} dry manure (Salazar-Sosa *et al*., 2007), which generates an organic fertilizer as a source of organic nitrogen (Helmy and Ramadan, 2009).

Regarding organic fertilizers, the productive capacity and physical-chemical conditions of a soil are benefited in the long term by the contribution of organic matter, because to the process called mineralization that transforms organic matter into nutrients assimilable by plants (Hernández *et al*., 2010). The mineralization increases with the enzymatic activity of the microorganisms, after the application of sources of organic matter (Fuentes *et al*., 2006) being positively influenced by the physical conditions such as the temperature (optimum of 26-36 °C) and the humidity (field capacity) in the arable layer of the soil (León-Najera *et al*., 2006).

A prerequisite to the use of manure as fertilizer is that it has to be treated for the elimination of pathogenic microorganisms. Solarization is a cost-effective and economical method that takes advantage of climatic characteristics such as high temperatures and solar radiation (Vázquez-Vázquez *et al*., 2010).

The application of bovine manure in the Comarca Lagunera has already been studied, for example, in the corn crop the best results were obtained applying 120 t ha^{-1} of manure (Salazar-Sosa *et al*., 2009). On the other hand, López-Calderón *et al*. (2015) indicate that 266 kg ha^{-1} of nitrogen can be obtained with the application of 133 t ha^{-1} of manure. While Vázquez-Vázquez *et al*. (2007), recommend applying dosages lower than 200 t ha^{-1} of manure in order to avoid the increase of electrical conductivity by the contribution of salts contained in the manure.

Another way to improve manure is to make vermicompost, which is the biodegradation of organic materials by the action of the california red worm (*Eisenia foetida*). It has been shown that the addition of vermicompost to soils significantly increases the growth and productivity of horticultural crops (Gutiérrez-Miceli *et al*., 2007). In addition, it has been proposed that the effects of vermicompost could present benefits such as improving physical conditions (porosity, moisture retention, aeration and drainage) and chemical (organic matter and nitrates) of the soil, stimulating vegetative growth and obtaining good yields (Lim *et al*., 2015), as well as the decline in pest density in crops (Razmjou *et al*., 2011), and the possible existence of biological mechanisms to stimulate plant growth (Ferreras *et al*., 2006).

On the other hand, watermelon is one of the agricultural products that are grown almost all over the world. Mexico produced 953 244 tons in 2013 (FAOSTAT, 2017) with an average national yield of 28.41 t ha^{-1} (SIAP-SAGARPA, 2017). In 2013, in the Comarca Lagunera (SIAP-SAGARPA, 2017), 924.1 hectares were cultivated with yields similar to the national average that range between 22.04 t ha^{-1} (Espinoza *et al*., 2006) and 26.7 t ha^{-1} (Cenobio-Pedro *et al*., 2006). For what is considered a high yield crop in the region.

The objective of the present study was to find the best treatment that increases the watermelon yield and improves the physical and chemical conditions of the soil; since the addition of organic fertilizers could partially replace mineral fertilization.

Materials and methods

The experiment was carried out during the spring-summer 2013 agricultural cycle in the Experimental Agricultural Field of the Faculty of Agriculture and Zootechnics of the Juárez University of the state of Durango (CAE-FAZ-UJED). The geographical location is 25° 46' 56" north latitude and 103°21’02” west longitude, with a height of 1 150 meters above sea level. The rainfall is 258 mm and the average annual temperature is 22.1 ºC.

The soils typical of the region are alluvial, Aridisol type, with a poor content of organic matter (0.9%); Neutral pH to low alkaline and rich in carbonates (Flores-Sánchez *et al*., 2015). The initial pH (7.2) is a common value of the calcareous soils of the Comarca Lagunera (Salazar-Sosa *et al*., 2010). In Table 1, the chemical characteristics of the soil at the three studied depths are observed before the experiment was established.

Table 1. Initial chemical characteristics of the soil of CAE-FAZ-UJED (2013).

Depth (cm)	pH	CE (dS m^{-1})	MO (%)	NO_3^-	Ca^+	Mg^+	Cl	HCO_3
				(mg kg^{-1})				
0-15	7.75	4.54	1.32	3.9	6.5	1.78	3.64	2.46
15-30	7.2	3.36	1.24	3.8	6.88	1.39	4.69	1.84
30-45	7.52	2.52	0.99	3.26	6.01	2.08	3.42	1.78

pH= soil reaction; CE= electrical conductivity; MO= organic matter; NO_3= nitrates; Ca= calcium; Mg= magnesium; Cl= chlorides; HCO_3= bicarbonate.

The genetic material used was watermelon variety PEACOCK WR124 which is recommended for its resistance to pathogens such as *Anthracnose* and *Fusarium* wilt. The transplant was carried out on March 28, 2013 using seedlings with three true leaves with a distance between plants of 0.5 m and 4 m between beds with a planting density of 5 000 plants ha^{-1} and 20 plants per experimental unit. It had 60 experimental units of 4 m wide x 10 m long giving an area of 40 m^2. A drip irrigation system was used through strips with drippers every 15 cm with an expenditure of 16 ml min^{-1} with a frequency of irrigation of 3 days applying a sheet of 42 cm considering an average evaporation of 0.96 cm day^{-1} of the evaporimeter tank type A in 111 days of the crop cycle.

The study factors were solarized manure (FE) and vermicompost (FV) at different levels. The FE considered five levels including two additional: A1 (control)= 0 t ha^{-1}, A2= 40 t ha^{-1}, A3= 60 t ha^{-1}, A4= 80 t ha^{-1}, A5 (120-60-00)= FQ. The FV had four levels: B1 (control)= 0 t ha^{-1}, B2= 3 t ha^{-1}, B3= 6 t ha^{-1}, B4= 9 t ha^{-1}. With these factors and their levels, the following treatments were generated: T1= absolute control; T2= 3 Mg ha^{-1} of vermicompost; T3= 6 Mg ha^{-1} of vermicompost; T4= 9 Mg ha^{-1} of vermicompost; T5= 40 Mg ha^{-1} of manure; T6= 40 Mg ha^{-1} of manure and 3 Mg ha^{-1} of vermicompost; T7= 40 Mg ha^{-1} of manure and 6 Mg ha^{-1} of vermicompost; T8= 40 Mg ha^{-1} of manure and 9 Mg ha^{-1} of vermicompost; T9= 60 Mg ha^{-1} of manure; T10= 60 Mg ha^{-1} of manure and 3 Mg ha^{-1} of vermicompost; T11= 60 Mg ha^{-1} of manure and 6 Mg ha^{-1} of vermicompost; T12= 60 Mg ha^{-1} of manure and 9 Mg ha^{-1} of vermicompost; T13= 80 Mg ha^{-1} of manure; T14= 80 Mg ha^{-1} of manure and 3 Mg ha^{-1} of vermicompost; T15= 80 Mg ha^{-1} of manure and 6 Mg ha^{-1} of vermicompost; T16= 80 Mg ha^{-1} of manure and 9 Mg ha^{-1} of vermicompost; T17= chemical fertilization; T18= chemical fertilization and 3 Mg ha^{-1} of vermicompost; T19= chemical fertilization and 6 Mg ha^{-1} of vermicompost; T20= chemical fertilization and 9 Mg ha^{-1} of vermicompost.

The treatments had three repetitions and were distributed in the field when considering an experimental design of random blocks with arrangement in strips. The data of the variables were analyzed with the statistical program SAS version 8 (2005), performing analysis of covariance to find if there are differences by the application of the treatments with respect to the initial conditions of the soil and separation test of DMS means ($p \leq 0.05$).

The soil samples were collected at the beginning and at the end of the experiment in each experimental unit, at three depths from 0 to 15, 15 to 30 and from 30 to 45 cm. The collection of the samples for chemical analysis was carried out manually with the help of a box auger placing 1.0 kg of substrate in transparent plastic bags of 2 kg capacity previously labeled for identification. Subsequently the samples were taken to the soil laboratory of the FAZ-UJED for the corresponding analyzes.

The estimated soil variables were organic matter (MO) determined by the Walkley-Black method (Walkley and Black, 1934); nitrates (NO_3) by nitration of salicylic acid (Robarge *et al*., 1983); electrical conductivity (CE), calcium (Ca), magnesium (Mg) and chlorides (Cl) by saturation paste of NOM-021-RECNAT-2000; Hydrogen potential (pH) 1: 2 p/v. Soil moisture (% m/v) was measured 65 days after the transplant (ddt), when the crop presented more than 50% of the phenological development, to observe the effect of moisture retention in the different treatments. Humidity was measured at two depths: from 0 to 7.5 and from 7.5 to 15 cm. The variables evaluated in the plant were yield and total soluble solids (°Brix) in fruit, which was measured with a digital refractometer Atago PAL-1, analyzing 12 plants per experimental unit.

The bovine manure was obtained from the stable of the FAZ-UJED and was solarized in lands of CAE-FAZ-UJED. While the vermicompost was acquired at the Technological Institute of Torreón (ITT), the characteristics of both fertilizers are shown in Table 2. The dosages with manure and vermicompost were applied to the soil one month before the transplant. The treatment with chemical fertilization (FQ) was applied in the recommended dose for the region of 120-60-00 NPK: kg ha^{-1} (Ruiz, 1985), which consisted of Urea (46-0-0) and MAP (11-52-0), which were applied in two parts, the first during the transplant and the second at 30 days ddt.

Table 2. Chemical characteristics of solarized manure and vermicompost used in the watermelon experiment.

Manure organic	P	N	CE	pH	MO	PSI
	(mg kg^{-1})		(dS m^{-1})		(%)	
Manure	45.89	6.89	7.76	8.09	5.98	4.77
Vermicompost	38.33	6.13	0.75	8.42	4.83	4.63

P= phosphorus; N= nitrogen; CE= electrical conductivity; pH= hydrogen potential (soil reaction); MO= organic matter; PSI= percentage of exchangeable sodium.

Results and discussion

The analysis of covariance for electrical conductivity (CE) at the end of the experiment, shows significant statistical difference in the interaction of manure and vermicompost in the three depths evaluated (0-15, 15-30, 30-45 cm) (Table 3). When comparing means of the interaction of solarized manure and vermicompost in the depth of 0-15 cm, the highest value of CE is observed in the level of chemical fertilization of 4.98 dS m^{-1}, however, it is statistically equal to the interaction of manure in the application of 80 t ha^{-1} and 3 of vermicompost (Table 4).

Table 3. Analysis of covariance (mean squares) of the final values of the chemical characteristics of the soil in each experimental unit, carried out at three depths.

FV	CE_1	CE_2	CE_3	pH_1	pH_2	pH_3	MO_1	MO_2	MO_3	$NO_3^-{}_1$	$NO_3^-{}_2$	$NO_3^-{}_3$
	(dS m^{-1})						(%)			(mg kg^{-1})		
R	0.2	0.05	0.01	0.003	0.004	0.003	0.01	0.02	0.001	0.02	1.31	0.84
FE	2.94^{**}	3.85^{**}	0.82^{**}	0.05^{**}	0.12^{**}	0.08^{**}	1.55^{**}	0.35^{**}	0.19^{**}	942.95^{**}	106.09^{**}	35.43^{**}
FV	0.21	3.12^{**}	0.94^{**}	0.02^{**}	0.19^{**}	0.23^{**}	0.44^{**}	0.04^{*}	0.07^{*}	318.31^{**}	2.12^{*}	10.99^{**}
FE∗FV	1.41^{**}	2.11^{**}	0.72^{**}	0.24^{**}	0.2^{**}	0.11^{**}	0.4^{**}	0.33^{**}	0.16^{**}	48.99^{**}	34.54^{**}	9.85^{**}
Error	0.11	0.04	0.01	0.003	0.01	0.007	0.01	0.01	0.02	0.01	1.96	0.77
Vin	0.12	0.01	1.57^{**}	0.53^{**}	0.22^{**}	0.25^{**}	0.06^{*}	0.05^{*}	0.0001	0.05^{*}	3.07	0.0002
CV	8.96	6.26	4.21	0.80	1.39	1.14	7.49	7.98	11.79	0.61	15.68	12.77

FV= variation factor; R= repetition; FE= dairy bovine manure; FV= vermicompost; FE∗FV= interaction of manure and vermicompost; Vin= initial values of the experimental unit; CV= coefficient of variation; CE= electrical conductivity; pH= soil reaction; MO= organic matter; NO_3^-= nitrates; 1= depth from 0 to 15 cm; 2= depth of 15 to 30 cm; 3= depth of 30 to 45 cm; *= significant $p \leq 0.05$; **= highly significant $p \leq 0.01$.

Table 4. Comparison of means for electrical conductivity (dS m^{-1}) in the interaction of manure and vermicompost treatments in depth from 0 to 15 cm at the end of the cycle.

Vermicompost treatment (t ha^{-1})	Manure treatments (t ha^{-1})				
	0	40	60	80	FQ
0	2.8 aβ	3.19 bβ	3.73 bβ	4.73 aα	4.98 aα
3	2.97 aβ	3.55 aβ	3.37 bβ	4.19 aα	3.02 cβ
6	2.75 aβ	3.51 aβ	4.55 aα	3.81 bβ	4.51 aα
9	3.34 aβ	4.06 aα	4.07 aα	3.36 bβ	3.47 bα

DMS= 0.614. Comparison of means between columns with latin letters and between rows with greek letters, equal letters are not statistically significant ($p \leq 0.05$).

This indicates that organic fertilization in these quantities did not increase CE significantly; if it had reached values higher than 5 dS m^{-1}, there would have been a decrease of 27% to 35% in watermelon production, as Romic *et al.* (2008). In this sense, Smith *et al.* (2001), point out that the increase of the CE for the dosage of organic fertilizers has to be taken into account, since this will affect the yield.

The values for pH show significant statistical difference ($p \leq 0.05$) in the interaction between manure and vermicompost in the three depths, due to the effect of the treatments with respect to the initial pH value in the soil (Table 3). The highest values (pH= 8.07) were found in the depth of 15-30 cm with the interaction of 3 and 6 t ha^{-1} of vermicompost and with 80 t ha^{-1} of manure, having values statistically equal to the interaction FQ and 9 t ha^{-1} of vermicompost (Table 5). Based on the analysis of covariance, the difference in pH is attributed to the effect of the initial conditions and not to the treatments, as found by Alburquerque *et al*. (2012), when applying 20 t ha^{-1} of bovine manure for the cultivation of watermelon.

Table 5. Comparison of means for pH in the interaction of manure and vermicompost treatments for depth 15 to 30 cm at the end of the cycle.

Vermicompost treatment (t ha^{-1})	Manure treatments (t ha^{-1})				
	0	40	60	80	FQ
0	7.3 bβ	7.85 aα	7.65 bβ	7.65 bβ	7.82 bα
3	7.82 aβ	8 aα	7.54 bβ	8.07 aα	7.94 aβ
6	7.82 aβ	7.86 aβ	7.95 aα	8.07 aα	7.26 bβ
9	7.71 aβ	7.96 aα	8.04 aα	7.62 bβ	7.95 aα

DMS= 0.124. Comparison of means between columns with latin letters and between rows with greek letters, equal letters are not statistically significant ($p \leq 0.05$).

The analysis of covariance for the percentage of MO in the interaction of manure and vermicompost shows significant statistical difference in the three depths (Table 3). However, the effect was greater up to the depth of 30 cm, this due to the treatments and the initial value, while in depth three (30 - 45 cm) the effect was only of the treatments. When comparing means, it is observed that in the interaction of 80 t ha^{-1} of manure and 9 t ha^{-1} of vermicompost, in the depth of 0-15 cm the percentage of organic matter was the highest with 3.23% (Table 6). This is relevant since it presented a higher value to the use of chemical fertilizer.

Table 6. Comparison of means for percentage of organic matter, at the end of the cycle, in the interaction of manure and vermicompost treatments for depth 0 to 15 cm.

Vermicompost treatment (t ha^{-1})	Manure treatments (t ha^{-1})				
	0	40	60	80	FQ
0	0.81 bβ	1.17 bβ	1.92 aα	1.95 bα	1.52 bβ
3	1.44 aβ	1.29 aβ	1.85 aβ	1.97 bα	2.15 aα
6	1.33 aβ	1.25 bβ	1.59 bβ	2.52 bα	1.45 bβ
9	1.63 aβ	1.55 aβ	1.93 aβ	3.23 aα	1.23 bβ

DMS= 0.301. Comparison of means between columns with latin letters and between rows with greek letters, equal letters are not statistically significant (DMS, $p \leq 0.05$).

Increases of MO have been reported in depths of less than 30 cm with bovine manure dosages (Salazar-Sosa *et al*., 2009; Vázquez-Vázquez *et al*., 2011; Yang and Aihua, 2016). Nascimento *et al*. (2016), found an increase in organic matter in a Neosol fluvic soil after a cycle of application with bovine manure for the cultivation of watermelon.

This differs from that found by Yang *et al*. (2016), which mentions that in silty soils with high contents of assimilable nutrients, they require at least two consecutive cycles applying composted bovine manure, on the same experimental area, to see statistical differences. Also in the case of the vermicompost the MO increases in strata smaller than 20 cm (Campitelli *et al*., 2011; Martínez *et al*., 2016).

The analysis of covariance for nitrate concentration (NO_3^-) in the interaction of manure and vermicompost shows significant statistical difference in the three depths (Table 3), but only in the depth of 0-15 cm is a significant effect of the initial value of nitrates in the soil. It is shown in the comparison of means (Table 7) the highest interaction with 39.71 mg kg^{-1} of nitrates in the treatments of 80 t ha^{-1} of manure and 9 t ha^{-1} of vermicompost. As well as similar concentrations with interaction in the application of 80 t ha^{-1} of manure and 3 t ha^{-1} of vermicompost with 36.76 mg kg^{-1}, representing an increase of 46% compared to the interaction of FQ and 9 t ha^{-1} of vermicompost with 18.35 mg kg^{-1}.

These values confirm the findings of Fortis-Hernández *et al*. (2009); Salazar-Sosa *et al*. (2004), where the highest concentration of nitrates in the fertilization with organic fertilizers for the cultivation of corn and tomatoes, respectively, is found in depths less than 30 cm. In this depth of soil is where physical conditions such as aeration and temperature favor the enzymatic microbial degrading activity of organic matter and the conversion of NH_4^+ to NO_3^- (Salazar-Sosa *et al*., 2003; Rivera and Martín, 2004).

The low concentration of nitrates in the treatments with 40 t ha^{-1} (Table 7) can be attributed to the low mineralization of the organic matter contributed by this treatment of bovine manure and vermicompost in addition, the available nitrogen could be immobilized by the microflora (Ferrera and Alarcon, 2001) and, consequently, the correct transformation of organic matter into assimilable forms for plants did not occur. It is important to take into account the amount of nitrogen available in organic fertilizers, as well as the levels applied so as not to affect the mineralization and conversion of organic matter to nitrogen (Brieva *et al*., 2016), otherwise it is important to add a source with higher nitrogen values (Palma-López *et al*., 2016).

Table 7. Comparison of means for nitrates (NO_3^-) in mg kg^{-1} in the interaction of manure and vermicompost treatments for depth 0 to15 cm at the end of the cycle.

Vermicompost treatment (t ha^{-1})	Manure treatments (t ha^{-1})				
	0	40	60	80	FQ
0	7.65 bβ	9.26 bβ	17.28 bβ	23.29 bα	9.32 bβ
3	8.76 bβ	8.24 bβ	16.79 bβ	36.76 bα	8.12 bβ
6	19.35 bβ	8.97 bβ	21.42 bβ	29.18 bα	8.73 bβ
9	21.75 aβ	9.78 aβ	31.32 aβ	39.71 aα	18.35 aβ

DMS= 0.129. Comparison of means between columns with latin letters and between rows with greek letters, equal letters are not statistically significant ($p \leq 0.05$).

With respect to moisture in the soil, 65 days after transplantation, shows significant statistical difference in the depths evaluated (0 to 7.5 cm and 7.5 to 15 cm) (Table 8). Of the interactions of means, the highest value was obtained in the depth of 7.5 to 15 cm with a value of 28.41% for the humidity in the soil at the levels of 40 t ha^{-1} of bovine manure and 9 t ha^{-1} of vermicompost (Table 9), being statistically equal to the interaction of FQ with all levels of vermicompost and similarly for the interaction of bovine manure and vermicompost at levels of 80 t ha^{-1} and 9 t ha^{-1}. This reflects one of the physical improvements to the soil by organic fertilizers (Castro *et al*., 2009).

Table 8. Analysis of variance for moisture in the soil at two depths (medium squares).

Variation factor	H_1	H_2
Repetition	0.11	1.26
Manure factor (FE)	7.29^{**}	6.43^{**}
Vermicompost factor (FV)	18.86^{**}	14.15^{**}
Manure and vermicompost interaction (FE∗FV)	0.054^{**}	0.68^{**}
Error	0.07	0.31
Coefficient of variation (CV)	1.04	2.12

H= average moisture percentage (v/m); 1= depth of 0-7.5 cm; 2= depth of 7.5-15 cm; *= significant $p\leq 0.05$; **= highly significant $p\leq 0.01$.

Table 9. Comparison of means at 65 ddt for moisture percentage by the gravimetric method (v/m) in the interaction of manure and vermicompost treatments for depth 7.5 -15.

Vermicompost treatments (t ha^{-1})	Manure treatments de (t ha^{-1})				
	0	40	60	80	FQ
0	24 bβ	27.8 aα	27.82 aα	27.79 aα	27.91 aα
3	25.21 aβ	24.97 bβ	25.61 aα	28.09 aα	25.7 aα
6	26.36 aα	25.84 aα	24.42 bα	23.64 bβ	26.9 aα
9	27.01 aα	28.41 aα	25.35 aβ	28.09 aα	28.06 aα

DMS= 2.8. Comparison of means between columns with latin letters and between rows with greek letters, equal letters are not statistically significant ($p\leq 0.05$).

Regarding yield, average yields of up to 31.8 t ha^{-1} were found, corresponding to 3 t ha^{-1} of vermicompost with FQ (Figure 1). Showing significant statistical difference ($p\leq 0.01$) only for the individual factors, but not in the interaction (Table 10). Obtaining the best yields of watermelon with the treatment 3 t ha^{-1} of vermicompost and FQ, and 6 t ha^{-1} of vermicompost and 80 t ha^{-1} of manure, both treatments being statistically equal (Table 11). The highest average value between vermicompost levels, with statistical difference, corresponded to the treatment of 3 t ha^{-1} (26.48 t ha^{-1}) with a numerical difference of 2.76 t ha^{-1} with respect to the lowest dose treatment of 6 t ha^{-1} of vermicompost.

These yields are similar to those reported by Espinoza *et al*. (2006) under a conventional production system with 22.7 t ha^{-1} and for a production system without padding and with FQ of 26.7 t ha^{-1} (Cenobio *et al*., 2006). When using solarized manure in the amount of 80 t ha^{-1} and compare it with the yield obtained with FQ, no significant differences were found, this agrees with what was pointed out by Trejo-Escareño *et al*. (2013) and Rodríguez-Dimas *et al*. (2009) in studies carried out in different crops.

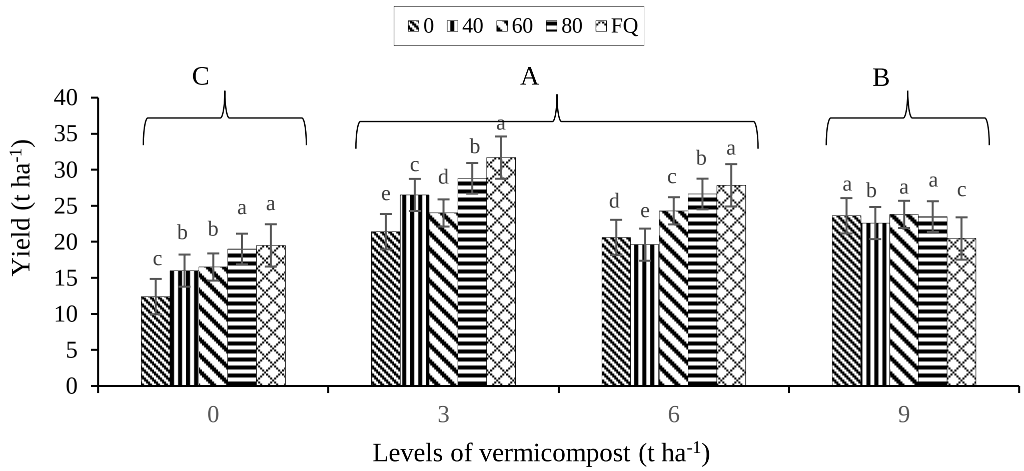

Figure 1. Watermelon yield averages in the treatments evaluated.

Table 10. Analysis of variance for yield and total soluble solids (mean squares).

Variation factor	Yield	Total soluble solids (°Brix)
Repetition	2.15	0.06
Manure factor (FE)	59.66**	0.95
Vermicompost factor (FV)	256.58**	0.52
Manure and vermicompost interaction (FE∗FV)	0.4	2.89
Error	1.03	0.93
Coefficient of variation (CV)	4.53	14.46

**= highly significant $p \leq 0.01$.

Table 11. Comparison of means for watermelon yield of manure and vermicompost treatments.

Manure treatments	Yield (t ha^{-1})	Vermicompost treatments	Yield (t ha^{-1})
0	19.65 c*	0	16.68 c
40	21.17 c	3	26.48 a
60	21.91 b	6	23.72 a
80	24.52 a	9	22.82 b
FQ	24.87 a		
	DMS = 0.59		DMS= 1.01

*= Comparison of different Latin letter means represent statistical differences between means.

The sweetness is related to the content of total soluble solids in watermelon (Aguyoh *et al*., 2010), in this experiment the fertilization with manure and vermicompost in its different levels, do not show significant statistical difference (Table 10), but a difference numerical (Figure 2). Similar results (Fatondji *et al*., 2008; Massri and Labban, 2014) confirm that organic fertilizers are not related to total soluble solids. According to market standards 8 degrees brix is sufficient for the product to have acceptance in addition to its good quality (Cenobio-Pedro *et al*., 2006).

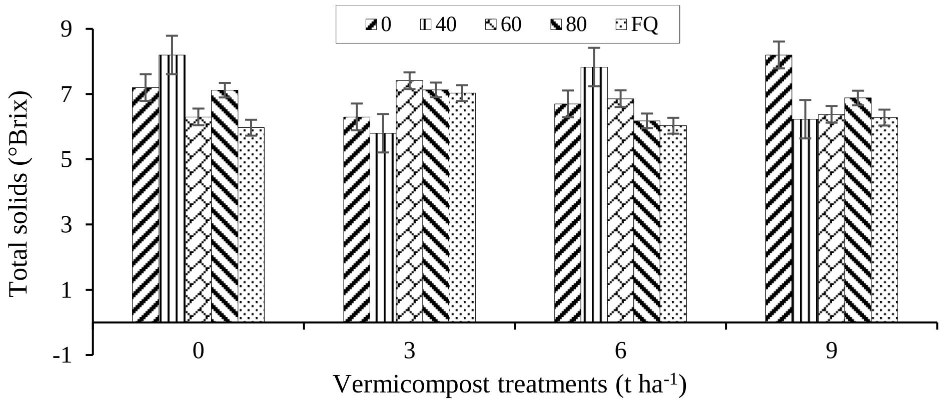

Figure 2. Averages for Brix degrees of watermelon in the treatments evaluated.

Conclusions

The treatment with the best performance was obtained with 3 t ha^{-1} of vermicompost and FQ with a yield of 32 t ha^{-1}. No treatment showed effects on total soluble solids. For the chemical characteristics of the soil the interaction of 80 t ha^{-1} of manure and 9 t ha^{-1} of vermicompost, increased to 2.42% the MO and 35.81 mg kg^{-1} the NO^{3-} in the depth 15 cm. The initial pH increased from 7.1 to 8.07 with the interaction of 80 t ha^{-1} of manure with 3 and 6 t ha^{-1} of vermicompost. The highest percentage of moisture 28.41 was obtained at a depth of 7.5 to 15 cm with 40 t ha^{-1} of bovine manure and 9 t ha^{-1} of vermicompost.

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