

## **ORGANIC MATTER AND MICROORGANISMS EVALUATION ON SOILS FROM AVOCADO (*Persea americana* Mill) ORCHARDS IN URUAPAN, MICHOACÁN**

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Avocado national production in Mexico is lead by the state of Michoacan with 85.85 % of the total production. In this Mexican state, 5,535 ha of avocado orchards are currently under organic management. However, studies on soil dynamics in these orchards are as poor as in those conventionally managed. The aim of this work was to evaluate the content of organic matter and Colony-Forming Unit (CFU) during two cycles of production as well as to quantify the presence, abundance and diversity of Arbuscular Mycorrhizal (Fungi AMF). In order to accomplish such objectives, samples were taken every three months from November 2003 and during two consecutive years of production. Eight soil samplings were conducted, determining organic matter and CFU, and spore number of 10 AMF species through four samplings. Mean organic matter on soil from organic management was 7.75 % (medium level), higher than mean organic matter found on soil from orchards under conventional management (3.77 %; low level). While CFU was 19.5 times higher in conventionally managed soils ( $564 \times 10^6$  CFU), as compared to soil under organic management ( $29 \times 10^6$  CFU). Mean AMF spores in organic managed soils were 62 % higher than in soils under conventional conditions. *Glomus constrictum* and *G. geosporum* were the most abundant species, with a mean of 408 and 323 spores, respectively. In contrast, *Scutelospora verrucosa* and *Gigaspora sp 1* were the least abundant, with a mean of 4 and 9 spores, respectively. Shannon Wiener diversity index (H) for AMF spores showed a mean of 2.3242, indicating high diversity among AMF species. H values for spore diversity among the two types of orchard management showed no differences. Nonetheless, while comparing soil from three different consecutive sampling dates, H index on October 2005 outstands with 2.6645. Lower H index were obtained for species *G. constrictum* (1.7737) and *Gigaspora sp 1* (1.2934).

# EVALUACIÓN DE LA MATERIA ORGÁNICA Y DE MICROORGANISMOS EN SUELOS DE HUERTOS DE AGUACATE *Persea americana* Mill. EN URUAPAN MICH.

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En México destaca Michoacán con el 85,85 % de la producción nacional de aguacate, que registra 5.535 ha con manejo orgánico, que al igual que el convencional, carece de estudios de evaluaciones sobre los cambios dinámicos del suelo. Los objetivos propuestos fueron los siguientes: evaluar el contenido de materia orgánica y UFC (Unidades Formadoras de Colonia de bacterias), en dos ciclos de producción; y cuantificar la presencia, abundancia y diversidad de HMA (Hongos Micorrizógenos Arbusculares). A fin de cumplir estos objetivos, realizamos ocho muestreos de suelo, durante dos años, determinando materia orgánica, UFC y en cuatro muestreos, número de esporas de diez especies de HMA. El promedio de materia orgánica para manejo orgánico fue 7,75 % (nivel medio), superior a 3,77 % (nivel bajo) en convencional, no así en UFC con promedio de 564148984 para manejo convencional, superior a 28900500 UFC en manejo orgánico. El número de esporas de HMA fue mayor en un 62 % en promedio, en manejo orgánico. *Glomus constrictum* y *Glomus geosporum* fueron más numerosas, con promedio de 408 y 323 esporas respectivamente. *Scutelospora verrucosa* y *Gigaspora sp. 1* fueron menos numerosas, con 4 y 9 esporas respectivamente. Los valores promedio de 2,3242 de los Índices de diversidad Shannon Wiener (H) de esporas de HMA indican alta diversidad. Entre los índices (H), no hay diferencias en diversidad de esporas en manejos de aguacate convencional y orgánico. Sin embargo, entre tres fechas de muestreos, sobresale el índice 2,6645, correspondiente al cuarto muestreo. Las especies *Glomus constrictum* (1,7737) y *Gigaspora sp 1* (1,2934) obtuvieron los menores índices de diversidad.

Palabras clave: unidades formadoras de colonias de bacterias, hongos micorrizogenos arbusculares

## I. INTRODUCTION

The production of 85 % of avocado in Michoacan, locates it like: 7<sup>o</sup> place in value of the national agricultural production; the world-wide leader in covered surface (29 %) and production (48.5 %) and like the first exporter, with 140 thousands ton/fresh year in and a value of the export of avocado processed of the order of 70.7 million dollars.

Nevertheless, the environmental impact is evident that it generates the link of the production by the prevailing conventional productive model. Which, as of the years 90s, has sensitized to producers and sectors, to favorably change to schemes of organic production of the avocado, adding itself the demand of avocado produced under technologies of insumos of low risk for the health of its consumers (Aguirre and Bárcenas, 2005).

In 1998 in Mexico they had single registered letter 307 has of organic avocado, at the moment in the 2006 register 6,150 ha of organic avocado and conversion certified, of which 91 % are located in Michoacán, 6 % in Nayarit, 2 % in Puebla and 1% in Veracruz. Also, Michoacan counts on 26 certified packings, 2 companies of cut and 1 “guacamolera” for the industrialization of the organic avocado, (Gioanetto, 2005).

But way similar to the conventional handling, it is lacked registries of evaluations of the possible changes that are happening in grounds with this modality of work, so that in the organic and conventional production, empirismes predominate, by the immediate necessities of you practice them daily in the culture for productive and commercial aims single. For that reason, to generate the knowledge of the dynamics of microorganisms and the contents of organic matter, in orchards of avocado under organic handling, will allow to explore possible differences in contents with respect to the conventional handling and to count on elementary information of the handling in the ground.

Hypothesis. “The contents of organic matter, Fungi Micorrizic Arbusculares HMA and Training Units of Colony of bacteria UFC, are in greater amounts in grounds under organic handling of the culture of the avocado, with respect to the conventional handling”.

General objective. To contribute to the generation of the knowledge of dynamics of the organic matter and the microorganisms of the ground, in orchards of avocado under organic handling and its possible economic and environmental advantages

Specific objectives:

Value the content of organic matter in orchard of avocado with organic handling and with respect to the conventional handling.

Quantific the conventional handling, during two cycles of production. presence, abundance and diversity of Fungi Micorrizico Arbusculares HMA and training units of colony of bacteria (UFC) of microorganisms, in relation to both types of handling of the avocado orchards.

## II. MATERIALS AND METHODS

### 2.1. Description of the sampling area.

The ground sampling was made every three months, having treated to include the four stations of the year, in the orchards: 1. “The Stones”, to 1800 msnm, of 40 ha, age of the trees of 5 years, handled organic from its establishment and 2. “The Park”, to 1740 msnm, of 4 has, age of the trees of 5 years, established and handled conventionally (with chemical, insecticide, fungicidas and herbicidas fertilizers).

Both located to the north of the city of Uruapan, under a Semicalid humid climate with abundant rains in summer (A) c (m) (w); established in a type of soil Andosol humic.

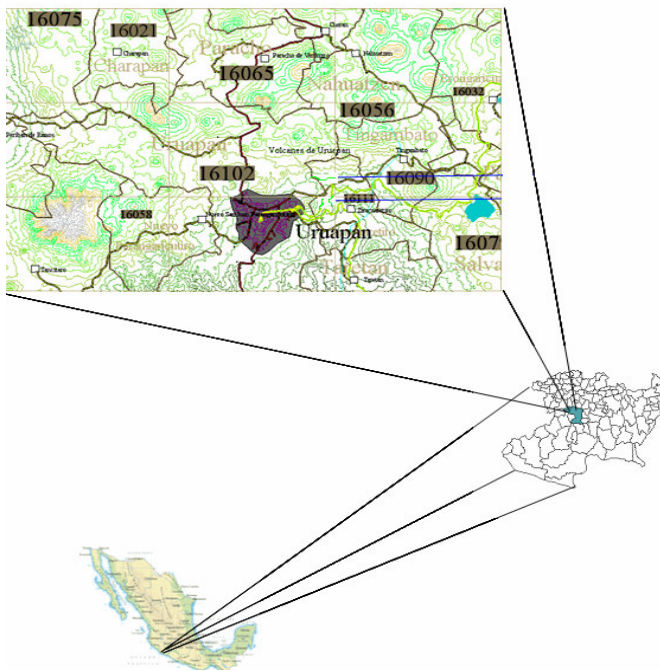


Fig 1 Location of the avocado orchards: “The Stones” (organic handling) and “the Park” (conventional), to the northwest of the City of Uruapan Mich.

A size of sample of six trees was used randomly, taking care of uniformity in size of the tree. The ground sample was made to depth of 30 cm, having obtained the sample by each tree of the four cardinal points, being generated six samples by each type of handling of culture and twelve altogether of all the work. With the

samples of each tree a common sample for organic matter and training units of colonies of bacteria was obtained.

## 2.2. Determination of Organic Matter.

In laboratory, using the Method of Walkley modified Black determined the percentage of the content of organic matter in both grounds of each orchard, according to the conventional mineral classification. ,

## 2.3. Quantification of Training Units of Colony (bacteria).

The technique of microbial total account was used, to know the number of viable microorganisms in the ground, through count of the number of colonies of bacteria that are developed in the sample after certain time and temperature of incubation, using the drained technique of dilution and in plate of agar (Ferrera- Cerrato *et al.*, 1993).

## 2.4. Count of Fungi Micorrizic Arbusculares.

The micorrizic quantification was evaluated according to the methodology of count of spores by means of the method of sifted and movement, (Carreón and Chávez, 2002).

## 2.5. Statistical analyses.

The results processed under the technique of the analysis of variance and in its case the significance test of averages of Tukey to 5 %. For the variables organic matter and it counts microbial total (UFC), was used the model:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$$

Of special way, for the spores case of variable HMA, in relation to the types of handling, the statistical model was applied:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \delta_k + (\beta\alpha)_{ij} + \varepsilon_{ijk}$$

For the diversity of the Fungi Micorrizogens Arbusculares, the index of Shannon Wiener was used, under the function:

$$H = - \sum_{i=1}^s p_i \log e p_i$$

With the previous thing, the program was used of I compute species diversity & richness, Mamiraúa project, of Hendersón and Seaby, 2005.

### III. RESULTS AND DISCUSSION

#### 3.1. Organic matter.

Table 1 Percentage of organic matter during the cycles of production (2004-2005) of avocado under handlings: organic and conventional.

Dates	Organic Handling %	Convencional Handling %
16 November 03	7.81	3.48
4 March 04	6.45	3.60
14 June 04	6.84	3.02
23 September 04	6.97	2.73
8 December 04	9.24	4.73
10 February 05	7.90	3.74
4 June 05	10.07	4.90
4 October 05	6.69	3.95

$\bar{X}$

7.75

3.77

The analysis of variance of the percentage of organic matter, during the cycle of production 2004-2005, in avocado under handlings: organic and conventional, it showed a value of calculated F of 55.83 and P>F of 0.000 (high statistical significance), therefore the average of 7.75 % for the organic handling of the avocado, is superior statistically to the average of 3.77 % of organic matter in the conventional handling. Then, for the orchard under organic handling they fall in average rank (6.0 – 9.0 %), however for the orchard with conventional handling in rank under (3.0 - 4,5 %), being of by means the rank moderately under (4.5 – 6.0 %), (Castellanos, 2000).

### 3.2. Training units of Colonies of bacteria (UFC).

Table 2 Microbial total Count (UFC/gr) during the cycle of production 2004-2005 in avocado, under handlings: organic and conventional.

Dates	Organic Handling	Convencional Handling
16 November 03	6 500000	69 000000
4 March 04	9750000	42 900000
14 June 04	8 125000	55 950000
23 September 04	4 700000	3 500000000
8 December 04	13 000000	16 800000
10 February 05	31429000	643442000
4 June 05	146 500000	176 000000
4 October 05	11200000	9100000

$$\bar{X} \quad 28900500 \quad 564148984$$

Here the analysis of variance of the microbial total account (UFC/gr) during the cycle of production 2004-2005 in avocado, under handlings: organic and conventional, was calculated F was of 1.5767 and  $P > F$  of 0.228, that it indicates, statistical nonsignificance, that is to say, that the average of 564148984 of U F C by gr of ground for the conventional handling of the avocado, does not surpass statistically to the average of 28900500 UFC in the organic handling.

### 3.3. Fungi Micorrizico Arbusculares.

With an integration of the three samplings made during 2005, in base in the total of esporas of HMA, from the found species, it was obtained:

Table 3 Concentrated of the total averages of esporas of HMA, in three samplings, during 2005.

Species	10 February	4 June	4 October
1 <i>Gigaspora sp 1</i>	13	7	45

2 <i>Scutelospora verrucosa</i>	3	1	3
3 <i>Scutellospora coralloidea</i>	36	40	84
4 <i>Acaulospora spinosa</i>	175	349	230
5 <i>Glomus tortuosum</i>	225	215	195
6 <i>Glomus geosporum</i>	380	495	343
7 <i>Glomus constrictum</i>	426	628	486
8 <i>Sclerocistis pachycaulis</i>	90	230	146
9 <i>Acaulospora scrobiculata</i>	291	347	236
10 <i>Gigaspora sp 2</i>	15	5	10

Table 4 Analyses of variance of the concentrated one of the total averages of spores of HMA, in three samplings, during 2005.

FV	GL	SC	CM	F	P>F
Species	9	844523.75	93835.97	38.45	0.000
Dates sampling	2	24848.88	12424.44	5.09	0.017
ERROR	18	43924.38	2440.24		
TOTAL	29	913297.00			

Table 5 Test of Tukey (5 %) of the concentrated one of the total averages of spores of HMA, in three samplings, during 2005.

Specie	$\bar{X}$ of 3 samplings	Classification
7 <i>Glomus constrictum</i>	513 esporas	A
6 <i>Glomus geosporum</i>	406	A B
9 <i>Acaulospora scrobiculata</i>	291	B C
4 <i>Acaulospora spinosa</i>	251	C
5 <i>Glomus tortuosum</i>	212	C
8 <i>Sclerocistis pachycaulis</i>	155	C D
3 <i>Scutellospora coralloidea</i>	53	D E
1 <i>Gigaspora sp 1</i>	22	D E
10 <i>Gigaspora sp 2</i>	10	E
2 <i>Scutelospora verrucosa</i>	2	E

Table 5, shows as *Glomus constrictum* and *Glomus geosporum* were excellent in superior amounts of four hundred spores; another second group that goes in greater amounts of 150, until near 300 esporas of HMA, is integrated by: *Acaulospora scrobiculata*, *Acaulospora spinosa*, *Glomus tortuosum* and *Sclerocistis pachycaulis*.



Thus, the group with smaller amount of esporas was with: *Coralloidea Scutellospora coralloidea* , *Gigaspora* sp 1, *Gigaspora* sp 2 and *Scutellospora verrucosa*.

Table 6. Test of Tukey (5 %) of the concentrated one of the total averages of spores of HMA, in three samplings, during 2005.

date sampling	AVERAGE	
2° (4 june)	231	A
3° (4 october)	178	A B
1° (10 february)	165	B

Thus, Table 6, details as the total average of spores in the second sampling (time of rains) were significantly different from the first sampling, with a difference of 29 %. Being like an interval, the last one of the samplings made in the count of spores of HMA, with a difference of 23 %, with respect to the value upper.

Table 7. Averages of the indices of Shannon Wiener, in the handlings: conventional and organic, in three samplings of 2005.

HANDLING	SAMPLINGS 2005			AVERAGE
	1° (10 feb)	2 ° (4 jun)	3° (4 oct)	
Conventional	2.2784	2.2309	2.5684	2.3592
Organic	2.1938	1.9132	2.7605	2.2892
<b>AVERAGE</b>	2.2361	2.0721	2.6645	<b>2.3242</b>

Table 8 Analyses of variance of the Indices of Diversity Shannon Wiener (h), of the periods of sampling, types of handling and species of HMA.

FV	GL	SC	CM	F	P > F
MUESTREOS	2	3.74	1.87	9.11	0.001
Tipos de manejo	1	0.07	0.07	0.36	0.560
Especies	9	13.17	1.46	7.13	0.000
Tipos manejo X spp	9	2.44	0.27	1.32	0.260
ERROR	38	7.80	0.21		
TOTAL	59	27.23			

Table 8 indicates: high significance of the indices of Shannon Wiener with respect to the three samplings made in 2005 and in relation to the ten identified species; nonsignificance between: the types of handling of the orchards and in the interaction types of handling and species of HMA.

Table 9 Test of Tukey (5 %) of the indices of Shannon Wiener, with respect to the three samplings made during 2005.

	MUESTREOS	MEDIA
3° (4 octubre)	2.6645 A	
1° (10 febrero)	2.2361 B	
2° (4 junio)		2.0721 B

Table 9 indicates that the greater index of diversity (h), was obtained in the third sampling of the four of October. Thus, the first and second sampling is similar, but they show discharge diversity (greater values of two).

Table 10 Test of Tukey (5 %) of the indices of Shannon Wiener (h) of the ten species of HMA identified in three samplings of 2005 Species

	Species	AVERAGE
6	<i>Glomus geosporum</i>	2.8311 A
5	<i>Glomus tortuosum</i>	2.7328 A
4	<i>Acaulospora spinosa</i>	2.6314 A B
3	<i>Scutellospora coralloidea</i>	2.6267 A B
8	<i>Sclerocistis pachycaulis</i>	2.5915 A B
2	<i>Scutelospora verrucosa</i>	2.4815 A B
10	<i>Gigaspora sp 2</i>	2.3076 A B
9	<i>Acaulospora scrobiculata</i>	1.9723 A B C
7	<i>Glomus constrictum</i>	1.7737 B C
1	<i>Gigaspora sp 1</i>	1.2934 C

Thus, the single Table 10 sample that the smaller indices of diversity, obtained with the *Glomus* species *constrictum* and *Gigaspora* sp 1, since the other eight species their indices were located in a rank of 1,9723 (*Acaulospora scrobiculata*) to 2,8311 (*Glomus geosporum*).

#### IV. CONCLUSIONS

The average of 7.75 % of organic matter (mean level), for the organic handling of the avocado, surpassed to the average of 3.77 % (low level) in the conventional handling.

In the variable microbial total account (UFC/gr), the average of 564148984 for the conventional handling, did not show significant difference with respect to the average of 28900500 in the organic handling of the avocado.

The number of spores of HMA was greater in a 62 % in average, the orchard under organic handling, with respect to the conventional handling, in addition of which the amounts are consisting of proportional differences from the first one (64 %), second (62 %) and third (77 %) samplings.

In three dates of samplings, the handlings: conventional and organic, the species of HMA *Glomus constrictum* and *Glomus geosporum*, were most numerous, with general average of 408 and 323 spores respectively.

The species of HMA *Scutelospora verrucosa* and *Gigaspora* sp 1 were less numerous, with general average of 4 and 9 spores respectively, during the three sampling periods.

The values average of 2.3242, the Indices of diversity of Shannon Wiener (h) of the spores of HMA, in handlings of avocado: conventional and organic, they indicate discharge diversity and between the indices of diversity in the handlings: conventional and organic there are differences in no diversity of spores.

Nevertheless between the three dates of samplings, it excels the index of 2.6645, the third sampling (4 October of 2005). The smaller indices of diversity, obtained with *Glomus constrictum* (1.7737) and *Gigaspora* sp 1 (1.2934). The other species their indices were located in rank of 1,9723 (*Acaulospora scrobiculata*) to 2,8311 (*Glomus geosporum*).

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