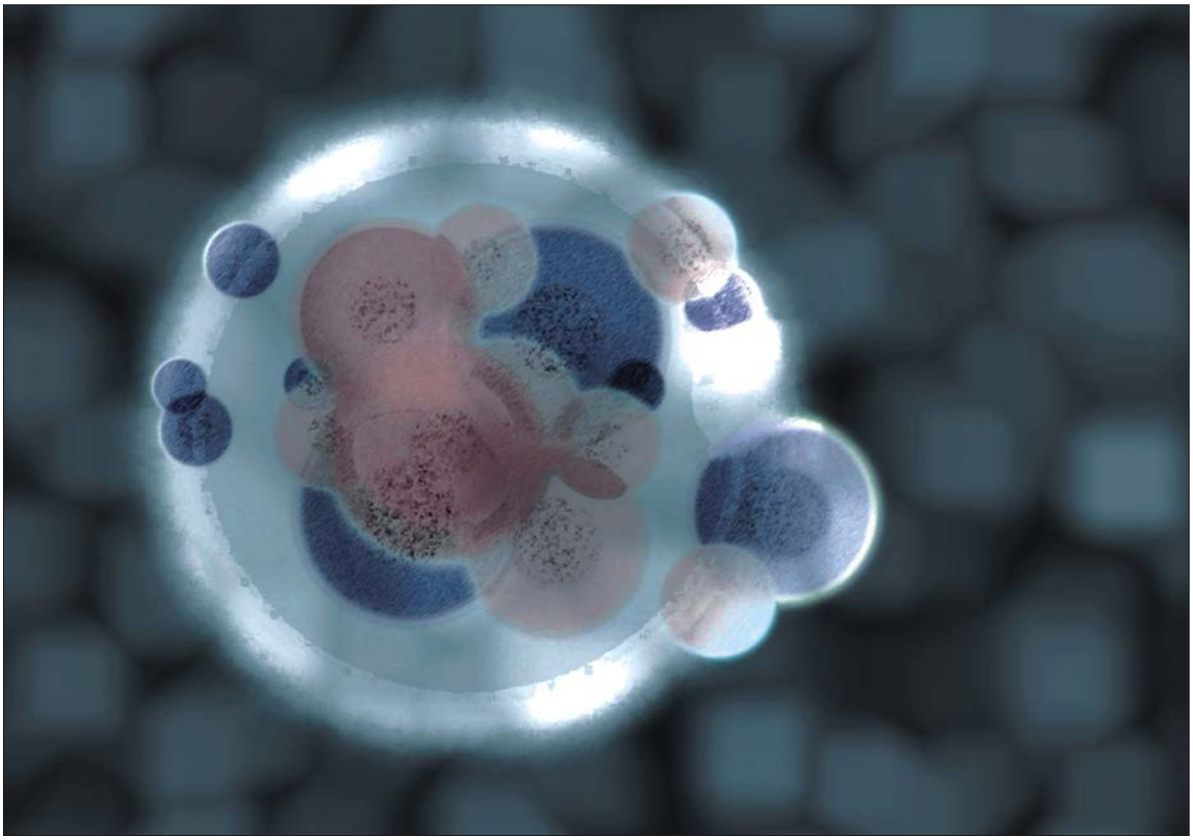

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Soil Organic Matter Particle and Presence of Earthworm Under Different Tillage Systems

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Abstract: The objective of the present research was to study the particle of organic matter and the presence of earthworm under conservation and traditional tillage during winter and spring seasons. The sampling site was experimental field of FIRA in Villadiego, Guanajuato. The soil and earthworm sampling was carried out in monoliths of 25×25×30 cm (side×side×depth), dividing the depth into strata: 0-10, 10-20 and 20-30 cm. An earthworm species was identified namely *Phoenicodrilus taste* under conservation and conventional tillage. *P. taste* showed a population of 328 individuals m^{-2} during the spring season under conservation tillage. This data coincided with the particle of soil organic matter in the 2 μm category, high organic carbon content (5, 3 y 2%), total nitrogen (0.3, 0.2 y 0.1%) and the depths of 0-10, 10-20 and 20-30 cm, respectively.

Key words: Conservation, *Phoenicodrilus taste,* carbon, nitrogen, monoliths

INTRODUCTION

The soil organic matter particle is considered as the separation of the structure fractions or aggregates (Polile *et al*., 2008). The soil organic matter particle is related to the biology of soil itself, one of them being earthworm. Earthworm is an invertebrate organism of soil fauna which contributes to the stability of agricultural and ecological systems (Birkás *et al*., 2004). This organism forms tunnels favoring infiltration, drainage, soil aeration and plant nutrient availability (Lavelle *et al*., 2006). Moreover, they participate in the formation and stability of macroaggregates and incorporate and degrade the soil organic residues which induce microbial activity (Desjardins *et al*., 2003). It is estimated that there are 129 earthworm species in Mexico and the major diversity is found in the States of Veracruz, Chiapas and Tamaulipas. These states have a humid climate and receive more than 1000 mm rainfall. There are no reports of this invertebrate in the states of Aguascalientes, Colima, Coahuila and Zacatecas possibly because these states have a significant desert area and the annual rainfall is less than 400 mm (Fragoso, 2001).

The presence of organic residues of the harvest along with the conservation tillage bears an important effect on the earthworm population (Caner *et al*., 2004; Chan, 2001). These orgamisms make vertical tunnels at a depth of 20-200 cm or more in some soils which function as continuous canals for the rapid circulation of water, nutrients and air and plant roots. In conventional tillage the structure deteriorates and the aggregate stability reduces which causes soil loss, low infiltration velocity, soil compactness due to agricultural machinery passage and higher water loss due to evaporation. The soil fauna is also reduced, principally earthworms (Andren *et al*., 2001; Brown *et al*., 2000). As far as soil fertility is concerned, there is low nutrient availability for plants and application of high doses of chemical fertilizers is necessary. The objective of this research was to study the organic matter particle and the presence of earthworm in a PelicVertisol under conventional tillage in the experimental field of FIRA, Villadiego, Guanajuato, Mexico.

MATERIALS AND METHODS

The research site is located in the Demonstration centre Villadiego, Guanajuato, Mexico in the fields of FIRA of Bank of Mexico where two tillage systems are practiced: conservation tillage and conventional tillage in the municipality of Valle de Santiago, Guanajuato, Mexico.

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The method employed for the extraction of the earthworm from the soil was that of Anderson and Ingram (1993). It consisted of establishing a transact at random and checking a soil monolith at each 5 m. A monolith of 25×25×30 cm (side×side×depth) was excavated and divided into three layers: 0-10, 10-20 and 20-30 cm of depth. Each layer was checked manually and earthworm and soil samples were collected for determination of their physical and chemical characteristics. The sampling was carried out in spring and winter.

The taxonomic classification and description of the earthworm species was done according to the keys of Reynolds (1977) and Fragoso and Reynolds (1997). These keys consider the color, size, segment number, setal distribution, the clitel location and dorsal sexual pores. The previously mentioned structures were examined with the help of a stereoscopic microscope, Petri dishes and entomological pins.

The bulk density was determined by the paraffin method using a clod of each depth (0-10, 10-20 and 20-30 cm) of the monolith in each plot under both tillage systems of each experimental field (Anderson and Ingram, 1996; Marinissen, 1994). The pH was measured in water (1:1.5) with the potentiometric method.

The particle was done by clay dispersion. Seventy grams of soil was weighed and sieved using 2 mm sieve. Two hundred milliliter of distilled water was poured into a 500 mL flask and shook for 2 h. Later the solution was size fractionation into 0-2, 2-20, 20-50, 50-250 and >250 μm. The samples obtained by the above mentioned particle were dried at 70°C for 24 h to determine organic carbon and total nitrogen organic carbon was determined by wet combustion. Total nitrogen of each tillage system was determined by semikjeldahl method.

The variance analysis, means test (Tukey, $\alpha = 0.05$) and correlation was done through the statistics package SAS (Statistical Analysis System) version 8.1 (SAS, 2002). The frequency of the identified earthworm species was determined.

RESULTS

The earthworm population and soil physical and chemical analysis: In conservation tillage maximum values of *P. taste* population were observed at 10-20 and 20-30 cm depths with 240 and 328 individuals m^{-2} while under conventional tillage a lower population of 192 and 80 individuals m^{-2} was exhibited (Table 1).

The earthworm population reduced from spring to winter: 240 to 60 individuals m^{-2} under conservation tillage and 192 to 72 individuals m^{-2} under conventional tillage. A soil pH of 5.2-6.8 and 6-6.8 was obtained under the conventional and conservation tillage systems respectively during spring as well as winter and the soil bulk density was 1.2 g cm^{-3} in both the tillage systems.

Table 1: The population of *Phoenicodrilus taste* and the soil conditions

Tillage systems	Depth (cm)	Earthworm (individuals m^{-2}) Spring	Winter	pH Spring	Winter	Density (g cm^3) Spring	Winter
Conservation	0-10	0	23a	6.6a	6.8a	1.2a	1.2a
	10-20	240a	60b	6.2b	6.3b	1.2a	1.2a
	20-30	328b	85c	6.0b	6.4b	1.0a	1.3a
Conventional	0-10	64a	0	5.2a	6.8a	1.1a	1.2a
	10-20	192b	72a	5.5b	6.8a	1.2a	1.3a
	20-30	80b	45b	6.0b	6.9a	1.3a	1.3a

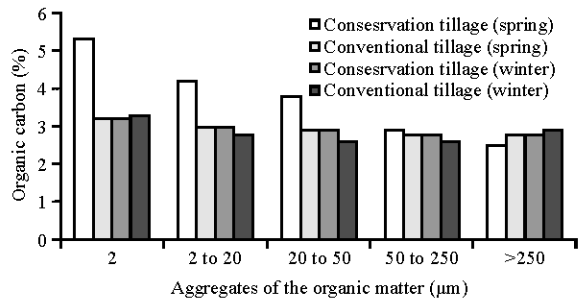

Fig. 1: Organic carbon of the different aggregate sizes of soil organic matter to a depth of 0-10 cm

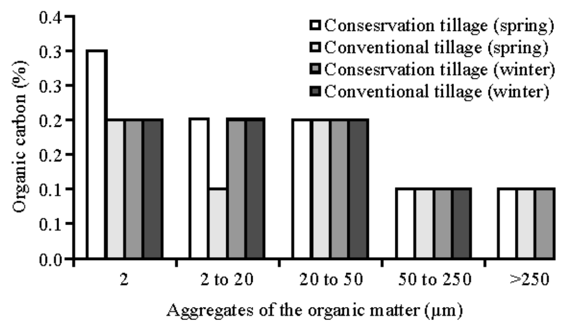

Fig. 2: Total nitrogen of the different aggregate sizes of soil organic matter to a depth of 0-10 cm

Organic carbon and nitrogen in different aggregates of the organic matter: Organic carbon and total nitrogen contents can be observed in Fig. 1 and 2 at a depth of 0-10 cm. Under conservation tillage system highest concentrations of organic carbon (5%) and total N (0.3%) can be seen during spring in the Pelic vertisol. Reduced concentrations of organic carbon and total N (0.3 a 0.1%) were observed at higher depths in both spring and winter. Under conventional tillage no change was noted. Moreover, the 2 μm fraction showed the highest concentrations of organic carbon and total N (Fig. 1, 2).

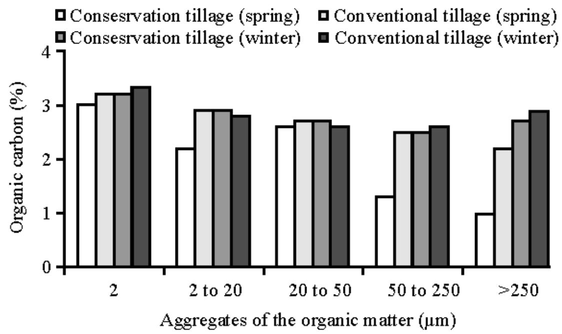

Fig. 3: Organic carbon of the different aggregate sizes of soil organic matter to a depth of 10-20 cm

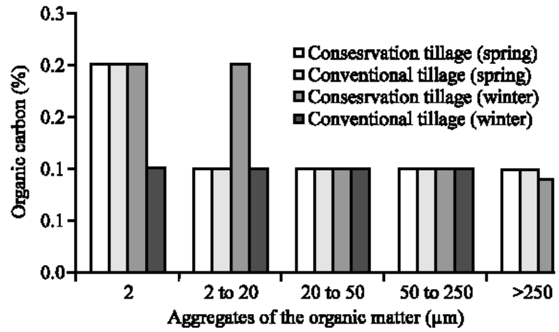

Fig. 4: Total nitrogen of the different aggregate sizes of soil organic matter to a depth of 10-20 cm

Figure 3 and 4 depict organic carbon and total N concentrations at a depth of 10-20 cm in both the tillage systems during spring and winter. A change was found in organic carbon concentration in conservation tillage where it tends to decrease from 2 to 1% in the aggregates of 2, 2-20, 50-250 and >250 µm while in the size fractionation of 20-50 µm, it tended to increase to 3% in the same tillage system. In the conventional tillage too, the organic carbon concentration is higher in both the seasons as compared to the conservation tillage. In the organic matter aggregates of 2 µm the total N concentration is the same in spring as well as in winter under conservation tillage while it shows a reduction under conventional tillage from spring to winter (0.2 to 0.1%). The aggregates of 2-20 and >250 µm have a high total N concentration in both the tillage systems during the winter season.

DISCUSSION

The earthworm species identified was *Phoenicodrilus taste* in the experimental field of FIRA villadiego, Guanajuato. (Fragoso, 2001) found the presence of *P. taste* in non perturbed woodlands of tropical climate in the Biosphere Reserve of Sian Ka´an, Quintana Roo. Fragoso and Reynolds (1997) mentioned that this earthworm species is found in very harsh climates and soils with different management.

In winter a reduced earthworm population under both the tillage systems was observed which may be due to soil compaction caused by heavy agricultural machinery used for maize harvest (Shakir and Dindal, 1997). The soil had a pH of 5.2-6.9 and a bulk density of 1.2 g cm^{-3} on the average during the spring as well as winter season respectively in both the tillage systems. *P. taste* is found in very harsh climates and in soils with varying agricultural management (Hangen *et al*., 2002; Chan and Barchi, 2007).

The neutral pH is a very important factor in the food and reproduction of the earthworm in the soil and in substrates where they grow. The majority of earthworm species grow at a neutral pH (Léonard *et al*., 2004). Under the intensive agricultural systems the presence of earthworm along with the application of inputs and a bulk density of 1.2 g cm^{-3} are ideal conditions for maintaining the water availability, reducing the nutrient loss by leaching and avoiding water stress in dry spells (Jeffey *et al*., 2004; Kladivko, 2001).

The means of maximum concentrations of organic carbon and total nitrogen of aggregates (0-250 µm) at 0-10 depth under conservation tillage are given in Fig. 1 and 2. The reason may be that this soil is very rich in both the elements in the three depths which did not affect the distribution of this specie (*P. taste*) under conservation and conventional tillage (Jaiyeoba, 2003; Jiménez and Decaëns, 2004).

The organic carbon and total nitrogen fractions may be due to the addition of the organic matter during the last 17 years as part of the field management at FIRA-Villadiego, Guanajuato. As it can be observed in Fig. 4, the total nitrogen content of 2 µm aggregate is high may be due to fertilizer applied and is leached with the irrigation in the layer 0-10 cm of depth. The nitrogen is more homogeneous in different depths in conventional tillage as compared to conservation tillage probably due to the earthworm activity (Langmaack *et al*., 2002; Kreuzer *et al*., 2004; Laurent *et al*., 2004).

CONCLUSION

The presence of earthworm specie *P. tastes* under conservation tillage influence in the particle-size fractions carbon content and nitrogen in spring as well as in winter. These demonstrate that earthworm populations modify the conditions soil and matter organic the tillage systems.

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