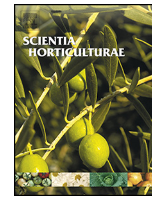
Scientia Horticulturae 172 (2014) 82–85

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti



Short communication

Effect of cover crops on the aggregation of a soil cultivated with papaya (*Carica papaya* L.)

Jailson Lopes Cruz[a,*], Luciano da Silva Souza[b], Naiara Célida dos Santos de Souza[c], Claudinéia Regina Pelacani[d]

[a] Embrapa Mandioca e Fruticultura, Cx. Postal 007, 44380-000 Cruz das Almas, Bahia, Brazil
[b] Universidade Federal do Reconcavo da Bahia, Cruz das Almas, Bahia, Brazil
[c] Centro de Energia Nuclear na Agricultura (CENA/USP), Universidade de São Paulo, Brazil
[d] Universidade Estadual de Feira de Santana, Feira de Santana, Bahia, Brazil

ARTICLE INFO

Article history:
Received 10 January 2014
Received in revised form 25 March 2014
Accepted 27 March 2014
Available online 28 April 2014

Keywords:
Soil management
Green manure
Soil structure
Fruit yield

ABSTRACT

This study examined the influence of eight types of cover crops, including a treatment with the interrows cleaned all time, on the weighted average diameter of soil aggregates (WAD), mass of soil aggregates, and crop yield of an intensively managed papaya orchards. It was observed that the lowest value for WAD was obtained in the samples from the cleaned interrows. The cover crops with calopo, sunn hemp, sorghum, pigeon pea and jack bean in association with sorghum had values of mass for soil aggregates with diameter between 7.93 and 2.00 mm greater than in soil where the plant cover was totally removed. There was a positive and significant correlation between the mass of larger diameter soil aggregates and WAD. The results clearly indicate that the addition of organic matter promoted by the cover crops supported the formation of aggregates with larger diameters and helped to improve the fruit yield of papaya, making them an important practice for sustainable agroecosystems.

1. Introduction

World soil resources are finite, unequally distributed among diverse regions, fragile and prone to degradation by misuse and soil mismanagement (Lal, 1997). Soils are constituted by countless micro-sites that are a function, not only of climatic and edaphic conditions, but also by peculiar factors like the presence of an organic matter particle, a root system, a micropore saturated with water and their capacity for gas exchange (Cardoso, 1992); the fractions known as soil aggregates encompass this universe. In agriculture, the way in which soils are used contributes to modify their properties (Azevedo et al., 2012; Müller et al., 2011). In the case of papaya (*Carica papaya* L.) plantations, the actual agricultural practices include a heavily mechanized system that is causing the compaction of soil surface. As a result, practices that protect soil of degradation must be developed. In recent years cover crops have gained popularity as part of modern sustainable agricultural systems (Picard et al., 2010), because cover crops can improve the soil aggregation, reduce the soil resistance to penetration, increase soil permeability, protect the soil from the direct impact of rain drops, thus reducing soil degradation (Cardoso et al., 2013). Due that, Souza (1996) and Carvalho et al. (2004) defended the idea that the use of cover crops in the interrows of commercial plantations can improve soil structure. For Brazilian conditions, several species have been suggested for use as cover crops (Bertoni and Lombardi Neto, 2005) and some as calopo, sunn hemp, pigeonpea and jack bean has obtained good performance in experiments conducted in the tropical environments of Brazil (Carvalho et al., 2004; Nascimento and da Silva, 2004; Cardoso et al., 2013). This study evaluated the effect of some that cover crops on the soil aggregate mass distribution by size classes, weighted average diameter of soil aggregates and fruit yield in an area cultivated with papaya.

2. Materials and methods

The experiment was carried out at the Palmares farm located in Porto Seguro city, State of Bahia, Brazil (latitude 16°26′ S and longitude 39°05 W). Climate in this region is characterized as humid to sub-humid with a mean annual temperature of 24.4 °C. Is important to highlight that the southern region of the state, where the Porto Seguro city is located, is the main papaya producer in Brazil. For the experiment, an area with papaya in the farm was used. The soil is classified as Ultisol dystrophic cohesive (EMBRAPA, 1999).

* Corresponding author. Tel.: +55 75 33128007.
E-mail address: jailson.cruz@embrapa.br (J.L. Cruz).

http://dx.doi.org/10.1016/j.scienta.2014.03.045
0304-4238/

Table 1
Influence of cover crops on soil aggregate mass distribution by size classes.

Treatments	Soil aggregate size class (mm)				
	7.93–2.00	2.00–1.00	1.00–0.50	0.50–0.25	<0.25
	g kg^{-1}				
Calopo	375.8 Aa[a]	176.4 Bbc	261.9 Bb	106.8 Bc	78.9 ABc
Sunn hemp	310.1 Aa	203.4 ABbc	306.7 Bab	109.9 Bcd	70.0 ABd
Sorghum (S)	286.7 Aa	209.4 ABb	299.8 Ba	123.2 ABc	80.9 Abc
Pigeonpea	373.4 Aa	202.1 ABb	266.9 Bb	95.8 Bc	61.8 Bc
Jack bean (JB)	270.3 ABab	234.9 Ab	301.1 Ba	111.8 ABc	82.4 Abc
JB + S	310.1 Aa	207.2 ABb	287.4 Ba	115.3 ABc	80.0 Abc
Spontaneous vegetation	237.5 ABb	232.9 Ab	327.4 ABa	119.4 ABc	82.8 Abc
Cleaned interrows	138.9 Bb	176.5 Bb	422.9 Aa	153.8 Ab	107.8 Ab
C.V (%)	23.6	12.5	15.4	17.4	25.7

[a] Means followed by same upper case letters, in each column, and lower case letters, in each line, indicate that do not differ by Tukey's test at 5% probability.

Soil preparation for planting of papaya consisted of two plow with harrow, leveled with two harrowing and subsoiling at the sowing line at a depth of 0.70 m. The soil was corrected and papaya crop was planted using the Sunrise solo variety, in a spacing of 3.8 m × 1.8 m. Irrigation by dripping was used in order to meet the water needs of the papaya plants. During the papaya's cycle, all treatments (soil correction/fertilization, weeding, and pesticide application etc.) were performed according to the production system of the farm. When the papaya orchard had 15 months an area of 4.378 m^2 within the area of papaya cultivation was chosen for the experiment installation, which consisted of the following treatments: T_1 – the area of the interrows was cleaned of vegetation at all times using herbicide (cleaned area); T_2 – spontaneous vegetation in the interrows, cutting when necessary to achieve a height of 10 cm; T_3 – pigeonpea (*Cajanus cajan*) planted in the interrows; T_4 – sunn hemp (*Crotalaria juncea*) planted in the interrows; T_5 – jack bean (*Canavalia ensiformis*) planted in the interrows; T_6 – calopo (*Calopogonio muconoides*) planted in the interrows; T_7 – sorghum (*Sorghum bicolor*) planted in the interrows; and T_8 – sorghum plus jack bean planted in the interrows. The experiment was organized in stripes, with each treatment occupying a total area of 547.25 m^2 (four lines, with 20 plants in each line) and a useful area of 164 m^2 (two lines, with 12 plants in each line). The density of seed in each cover crop, in kg/ha, was: 30 for sorghum, 40 for sunn hemp, 60 for pigeon pea, 60 for calopo, 160 for jack bean and in the treatment 8 was used 80 of the jack bean plus 15 of sorghum. The planting of these species was done in the interrows of the papaya cultivation. The interrows were not irrigated. Five day before cutting cover crops, ten plants of papaya were chosen at random to evaluate the fruit yield. In these plants, the harvest was performed twice for week during a period of four months, always at the ripening stage 2. The number of fruits per plant and the mass of each fruit were recorded and, at the end, the yield was determined for all treatments. One hundred and twenty days after planting all cover crops were cut 10 cm above ground level and left in the interrows. Sixty days after cut, soil samples (up to 20 cm depth) were collected for the physical analyses. From each treatment, four composite soil samples were collected (four replicates). Each composite sample was the product of mixing five simple samples taken randomly in the interrows. The composite samples were taken to the soil physics laboratory of the Embrapa Cassava & Fruits Crops for processing and analyses of the soil aggregates, including size distribution and weighted average diameter, as described in EMBRAPA (1997). Analyses were performed using a sample of aggregates between 7.93 and 2 mm of diameter, previously moistened by capillarity. After, the samples were wet sieved through a series of four sieves (2.00, 1.00, 0.50, and 0.25 mm) and vertically stirred in water for 15 min. At the end of the 15 min. cycle, the stable aggregates from each sieve were gently back-washed off the sieve into 250 mL glass beakers. Aggregates were oven dried (105 °C) e weighed. A Tukey's test (5% probability) was used for the comparisons among treatments.

3. Results and discussion

The cover crops with calopo, sunn hemp, sorghum, pigeon pea and jack bean in association with sorghum had values of mass for soil aggregates with diameter between 7.93 mm and 2.0 mm greater than the cleaned area (Table 1). The highest absolute value for this soil aggregate class was of 375.8 g kg^{-1} of dry soil, found in the calopo treatment, while the value in the cleaned treatment was of only 138.9 g kg^{-1} of dry soil, a result 170% higher. Even for this class of soil aggregates, the jack bean and spontaneous vegetation also showed mass value higher than the control, but statistically identical to the plot without cover crops. However, jack bean and spontaneous vegetation had values of soil aggregates with diameter between 2.0 and 1.0 mm that statistically outperformed the cultivated plot without cover crop. So, the joint evaluation of the mass value of soil aggregates of size between 7.93 and 2.00 mm and between 2.00 and 1.00 allowed to infer that all cover crops, including the native vegetation, promoted higher levels of soil aggregation than those found in the area that was cleaned all time. According to Loss et al. (2009), the cover crops, mainly legumes, promote a better development of the root system in the soil layers and increase the soil availability of elements such as carbon and nitrogen. As a consequence, there is an improvement in soil aggregation and the formation of larger aggregates. In fact, Wohlenberg et al. (2004) suggested that organic matter and root development are the main factors responsible for the formation of larger aggregates. This information can be used to explain the results found in the present work. It is known that soil aggregation controls internal water, air and heat movements as well as root growth. Therefore, the soil aggregates with larger diameters, as the ones verified in the areas where vegetal covers were used, can support gas exchange and water drainage, improving the conditions for papaya cultivation.

In general, there was a tendency for the treatments with vegetal covers to present lower values of soil aggregate mass with diameter less than 1.0–0.5 mm. When analyzing aggregate classes within each treatment, it was verified that only the calopo and pigeon pea treatments had higher values of soil aggregate mass in the class from 7.93 to 2.00 mm while the samples from cleaned treatment had the higher values in the classes from 1.0 to 0.5 mm, 0.50 to 0.25 mm, and lower than 0.25 mm. As mentioned, soil aggregates with smaller sizes can affect water movement and induce an oxygen deficiency, consequently impairing root growth and can produce a negative impact on the productivity of crops such as papaya plantations.