Organic Mulch Impact on Vegetative Growth, Productivity and Fruit Quality of "Anna" Apple Trees

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Abstract: This experiment was conducted in two successive seasons (2016 and 2017) on 10-year-old "Anna" apple trees planted at 3*4 m apart in sandy soil under drip irrigation system at 6th October company orchard, Ismailia, Egypt. The objective was to study the effect of organic orchard floor management systems (peanut shells and wood chips with three layers differed in thickness; 0.0 control , 7 and 15 cm) on soil properties, weed control, vegetative growth, tree yield and fruit quality. The treatments were arranged in a randomized complete block design.The application with thicker layer of organic orchard floor management systems (wood chips and peanut shells) decreased soil temperature (°C), increased soil moisture (%) and was more effective in suppression weed growth. Peanut shells mulch increased number of leaves/shoot and leaf area per shoot (cm^2) while, 7 cm thick of peanut shells increased number of shoots per branch. However, both wood chips and peanut shells increased shoot length. Thicker layer of wood chips increased tree volume (m^3) whereas thicker layer of peanut shells increased trunk cross sectional area (TCSA m^2). As for "Anna" apple tree productivity, the thicker layer of wood chips increased number of fruits per tree, average fruit weight (g) & length (cm), fruit shape index, tree yield (kg) and yield efficiency however, both wood chips and peanut shells increased fruit diameter (cm) while, 15 cm thick of peanut shells increased soluble solids content (SSC%). In addition, the thicker layer (15 cm) of organic mulch materials especially wood chips can be recommended for mulching in "Anna" apple orchards.

Keywords: Apple - Anna - orchard floor management system OFMS - mulch - organic OFMS - organic mulch – wood chips – peanut shells - organic mulch thickness

INTRODUCTION

Apple is the most important temperate fruit crop and has been adapted to various climates from the extreme cold of places such as Siberia and North China to the much warmer environs of Columbia and Indonesia (Janick *et al*., 1996). "Anna" is a cultivar of apple grown widely in Egypt with a total cultivated area of 71577 feddan, produced 726794 tons, from which 250 feddan are in Ismailia governorate according to the Ministry of Agriculture and Land Reclamation of Egypt 2019.

Orchard floor management (OFM) is a critical aspect of apple growing which enhance impact in organic fruit production. Practices of floor management include soil covers (mulches) and their management, as well as weed management. Several benefit effects of organic or inorganic mulches have been studied under various conditions. These effects, depending on the type of mulch used, include higher soil moisture retention that provides a delay in the onset of irrigation; greater soil nutrients levels that reduce fertilizer application; soil temperature buffering improves root development and budburst. At the same time, mulching improves weed control; increases soil organic matter; vegetative growth and yield (Neilsen *et al*., 2003; Treder *et al*., 2004).

In recent years, low water availability and nutrition remain as problems because most orchard irrigation is done by ground water in newly reclaimed land. So, new practice protocols need to be solved these problems. OFM is the application of suitable materials to the soil surface to maintain water to trees in a synchronized way and has a positive effect on the nutritional and biological status of the soil which leads to improve the vegetative growth and increase the yield.

This experiment aimed to study the effect of two different organic materials (peanut shells and wood chips) with three layers differed in thickness (0.0 control, 7 and 15 cm) for each on soil properties, weed control, vegetative growth and tree yield.

MATERIALS AND METHODS

This experiment was performed during the two successive seasons of 2016 and 2017 on 10-year- old "Anna" apple trees planted at 3*4 m apart in sandy soil under drip irrigation system at 6th October company orchard, Ismailia, Egypt..

The experiment included two organic materials (peanut shells and wood chips) were applied. Each one was laid underneath the tree canopy in a strip of 1m on each side of tree and with a C: N ratio of 13:1 and 48:1 for peanut shells and wood chips, respectively.

For thick layer of organic materials, peanut shells were applied at 7 and 15 cm, thick layer which equal to 25 and 50 kg/1.8 m^2, respectively, while wood chips were applied at 7 and 15 cm, thick layer which equal to 15 and 30 kg/1.8 m^2, respectively, and compared to control (bare soil). The treatments were hand-applied and frequently observed through the study to keep the thickness of the mulch constant in order to provide a shading effect for weed suppression, and to maintain soil moisture. Consequently, the experiment comprised five treatments arranged in a randomized complete block design and each treatment was replicated four times on one tree per each. All treatments were applied before bud burst.

The following parameters were estimated:

I. Soil moisture and temperature were measured on mid-April and mid-May at 10 and 15 cm depth, at a

distance of 75 cm from trunk. Soil moisture was determined gravimetrically before irrigation. While soil temperature was measured below soil surface by using a digital soil thermometer (Digital Therm. Lab "8" stem Hi-Temp. – China).

II. Relative Water Content (RWC)

In each season, periodical samples of ten fully developed leaves on the 7th node of the current shoots were taken from each tree on mid-April, and mid-May. Discs of 2.5 cm in diameter were taken from each sample leaves and rapidly weighed, floated on distilled water until they attained constant weight, reweighed to determine turgid weight and then oven dried at 75 C for 24 h to determine dry weight. RWC was calculated using the following equation according to Yamasaki and Dillenburg (1999).

$$\text{RWC} = \frac{\text{Fresh weight (g)} - \text{dry weight (g)}}{\text{turgid weight (g)} - \text{dry weight (g)}} \quad 100$$

III. Weed management

For according weed density (No. of weeds/m^2), permanent quadrants of 1.0 m^2 were randomly fixed under each tree before the emergence of weeds, number of weeds counted at the end of the growing season and expressed in number of weed/m^2. Weed control efficiency was expressed in percentage and calculated by using the following formula:

$$\textbf{Weed control efficiency (\%)} = \frac{\text{Dry matter of weeds in control} \quad \text{dry matter of weeds in treatments}}{\text{Dry matter of weeds in control}} \times 100$$

IV. Vegetative growth parameters

All the following vegetative parameters were measured at the end of each season (on mid-Aug.)

IV.1 Number of shoots per branch

Four branches, one from each side of the tree were chosen and its lengths (cm) were measured. Number of emerged shoots reached equal to or more than 30 cm were counted per each branch.

IV.2 Number of leaves, leaf area per shoot and Shoot length

Five of current shoots per tree were chosen. The number of leaves on each shoot was counted and the length of each one was measured. In each season, 20 healthy mature leaves developed on 6th and 7th nodes of the shoot were taken per tree. Leaf area (cm^2) was calculated by the following equation of Ahmed and Morsy (1999):

Leaf area (cm^2) = (0.73 *(leaf length * leaf width) + 0.16)

IV.3 Shoot density (%)

In both seasons, four branches, one from each side of the tree were chosen and theirlengths (cm) were measured. Number of emerged shoots reached equal to or more than 30 cm were counted per each branch. Shoot density was calculated as the following formula:

Shoot density (%) = shoot number per branch / branch length.

IV.4 Tree volume (m^3)

Tree height (m), and canopy diameter (m) were measured, then tree volume was calculated by the equation:

Tree volume (m^3) = (4/3)* (canopy diameter/2)^2 * (tree height) * (3.14)

IV.5 Trunk cross sectional area (TCSA cm^2)

Trunk circumference of each tree was measured at an estimated 30 cm above the soil surface and subsequently converted into TCSA as an indicator of overall tree size and the following equation was used as mentioned by Popescu and Popescu (2015).

TCSA (cm^2) = (trunk circumference)^2 / 4* 3.14

V. Yield attributes

In each season, at harvest time, 30 and 21 June in 2016 and 2017 respectively, both number and weight of fruit per tree were recorded. Average fruit weight was calculated. Also, yield efficiency (kg/cm^2) was measured as a ratio of yield of each tree (kg) and TCSA (cm^2) at the end of growing season and expressed as kg/cm^2 as follow.

Yield efficiency (kg/cm^2) = yield per tree (kg) / TCSA (cm^2) (Westwood, 1993)

VI. Fruit quality

VI.1 Shape index

At harvest date, five fruits per tree were selected randomly and fruit length and diameter (cm) of each fruit was determined using varnier caliper. Fruit shape index was evaluated as following:

Fruit shape index = fruit length/fruit diameter (Cohen *et al.,* 1972).

VI.2 Firmness (kg/cm^2)

Fruit firmness was measured on two equatorial opposite sides of 6 fruits (after peeling) from each of the replicate using a penetrometer (Magness, Traylor, Yakima, Washington) fitted with an 11 mm tip.

VI.3 Starch index

The starch test involved transversely bisecting six fruits perpendicular to the core and dipping the freshly cut surface of the top half of the fruit into an iodine solution (15g potassium iodide and 10g iodine per liter) for one minute and using a grading scale (1 : 9) according to Blanpied and Silsby (1992).

VI.4 Soluble solids content (SSC%)

Soluble solids content in composite juice of sample was measured by using LCII-Digital refractometer (Medline Scientific, United Kingdom, SR-95).

VI.5 Juice titratable acidity (TA%):

The same juice used in SSC was also used for titratable acidity which was titrated against 0.1 N NaOH solution using two or three drops of phenolphthalein as an indicator up to PH 8.1 (pink colour end point). The

titratable acidity was expressed as milligrams of malic acid per 100 ml of apple juice.

VI.6 SSC/acid ratio

The experiment comprised five treatments arranged in a randomized complete block design and each treatment was replicated four times on one tree per each. the experiment was designed in one - way analysis of variance. Data gained were analyzed utilizing CoStat version 6.303 1998-2004 by analysis of variance according to Steel and Torrie (1980) and the means were compared using least significant differences (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

I. Soil moisture and temperature

In each season at depths (10, 15cm) in mid-April and May, wood chips or peanut shells was significantly decreased the soil temperature when compared with control (unmulched treatment) as shown in table 1. On the other hand, soil temperature was slightly recorded higher values [(26.8, 24.5°C), (29.98, 27.06°C) as average of two depths for mid-April and mid-May in the first and second seasons, respectively] than that recorded under wood chips [(26.77, 23.5°C), (28.88, 26.56°C) as average of two depths for mid-April and mid-May in the first and second seasons, respectively]. These results are in line with findings of Hartley *et al.* (1996) who noted a reduction in soil temperature under sawdust. Similar effect of wood chips on soil temperature observed by Treder *et al.* (2004), by Nicholson (2012) on apple trees. It could be seen in both seasons, depths (10-15 cm) and in mid-April and May that soil temperature under mulch was significantly decreased as a thick layer of mulch increased compared to control.

In both seasons and depths (10 and 15 cm), Soil moisture under organic mulches was significantly affected by application of peanut shells and wood chips as organic mulches during mid-April and May (Table 1). However, significant higher soil moisture was observed in the soil under 15 cm thick wood chips mulch than that under 15 cm thick peanut shells mulch. The increment in soil moisture under wood chips mulch may be ascribed to reduce evaporation by decreasing the amount of radiant energy absorbed and minimizing air flow at the soil surface (Melloulli *et al*., 2000). These results are in conformity with those of Smith *et al*. (2000) who reported that soil moisture is higher under mulched trees with wood chips than unmulched trees. In addition, it is evident that soil moisture was significantly increased by increasing the thick mulch layer with either wood chips or peanut shells mulch.

II. Relative water content (RWC)

In each season, and in general, during mid-April and May, both peanut shells and wood chips as organic mulches were significantly affected relative water content (RWC) (Table 2). However, in mid-April, 15cm thick wood chip mulch had significant higher RWC than 15cm thick peanut shells mulch and control. However, no significant differences were found between them for RWC during mid-May in both seasons although, RWC had higher in leaves of trees grown over 15cm thick wood chips mulch. The lowest RWC was obtained from trees grown over unmulched treatment (0.0cm thick mulch). The increase in available water due to using organic mulches can affect the water uptake by tree resulted in more water status in the tree; thereby, RWC increased (Glover *et al.*, 2000 and Bronic and Lal, 2005).

Table (1): Effect of different organic orchard floor management systems on soil temperature (°C) and moisture (%) at depths of 10 & 15 cm of "Anna" apple orchard during 2016 & 2017 seasons

Treatments		2016							
		Sampling date on							
		Mid April		Mid May		Mid April		Mid May	
		Soil Temperature (°C) at depth of (cm)				Soil moisture (%) at depth of (cm)			
Materials	Thickness (cm)	10	15	10	15	10	15	10	15
P.S	7.0	26.70BC	26.90B	29.20 B	29.30B	3.38 C	5.70 C	7.59 C	10.29 C
	15.0	26.50BC	26.95B	28.85 C	29.00D	4.00 B	6.75 B	10.70 A	12.39 B
W.C	7.0	26.80 B	27.00B	29.05 B	29.10C	3.55BC	5.80 C	8.70 B	10.70 C
	15.0	26.35 C	26.75B	28.65 D	28.75 E	4.85 A	7.90 A	10.65 A	13.15 A
Control	0.0	27.25 A	27.35A	29.60 A	29.85A	3.15 C	4.50 D	3.85 D	3.95 D
		2017							
P.S	7.0	24.60 B	24.80A	27.23 B	27.30B	3.40 D	4.39 D	6.40 C	7.10 C
	15.0	23.40 D	23.55B	26.86 C	26.85C	4.85 C	5.25 C	8.75 B	9.15 B
W.C	7.0	24.00 C	23.80B	26.68C	26.55D	5.89 B	6.49 B	8.50 B	9.05 B
	15.0	23.10 E	23.20C	26.45 D	26.55D	6.29 A	7.50 A	10.65 A	11.35 A
Control	0.0	24.85 A	24.95A	27.55 A	27.85A	2.45 E	2.95 E	3.10 D	3.35 D

Values followed by the same letter in each column are not statistically different at 5%.
P.S= peanut shells, W.C= wood chips.

Table (2): Effect of different organic orchard floor management systems on Relative water content (RWC%) of "Anna" apple orchard during 2016 and 2017 seasons

Treatments		Sampling date			
Materials	Thickness (cm)	Mid April		Mid May	
		2016	2017	2016	2017
P.S	7.0	65.74 C	58.01 C	57.69 B	49.37 B
	15.0	71.22 B	64.83 B	65.39 A	59.95 A
W.C	7.0	66.31 C	58.18 C	60.43 B	53.07 B
	15.0	76.71 A	70.52 A	66.07 A	63.68 A
Control	0.0	53.74 D	47.65 D	49.99 C	43.31 C

Values followed by the same letter in each column are not statistically different at 5%.
P.S= peanut shells, W.C= wood chips

III. Weed management

In both seasons, the organic OFMS had a significant effect on number of weeds per m^2 (weed density) as compared to unmulched treatment (control) (Table 3). Thicker layer (15 cm) of mulch in either peanut shells or wood chips was more effective in suppression of weed growth compared to 7 cm thick layers of mulches. In this respect, Mika *et al*. (1998), Treder *et al*. (2004) and Edgars (2005) reported that no significant differences between organic mulches however, thicker wood chips mulch (15 cm thick) had lower fresh weed weight (12.7-15.25 g/m^2) and lower dry weed weight (2.30-2.55 g/m^2) in the two seasons, respectively. These findings are in harmony with those reported by Rowley *et al.* (2011), Solomakhin *et al.* (2012) on apple trees and by Kacan and Boz (2014) with peanut shells and sawdust mulches on grapevines. In general, the different organic mulches had significant effect on weed control efficiency (Table 3). Though, as average of the two thick layers of each mulch, it could see that higher weed control efficiency was observed under wood chips mulch (88.01-87.81%) than peanut shells mulch (76.79-76.35%) and control treatment (0.0-0.0%) in both seasons, respectively. It could be seen that as thick layers of mulch increased, weed control efficiency also increased.

Table (3): Effect of different of organic orchard floor management systems on weed control of "Anna" apple orchard during 2016 and 2017 seasons

2016					
Treatments		Number of weed /m^2 (weed density)	Fresh weed weight (g/m^2)	Dry weed weight (g/m^2)	Weed control efficiency (%)
Materials	Thickness (cm)				
Peanut shells	7	8.00 B	33.97 B	6.45 B	76.28 C
	15	6.50 B	33.95 B	6.17 B	77.29 C
Wood chips	7	7.25 B	27.87 B	4.22 BC	84.46 B
	15	4.75 B	12.70 B	2.30 C	91.54 A
Control	0	31.25 A	193.15 A	27.22 A	0.00 D
2017					
Peanut shells	7	8.25 B	40.77 B	7.09 B	76.35 C
	15	6.75 B	39.67 B	7.00 B	76.35 C
Wood chips	7	7.50 B	33.45 B	4.76 BC	84.11 B
	15	4.75 B	15.24 B	2.55 C	91.50 A
Control	0	33.00 A	231.78 A	30.07 A	0.00 D

Values followed by the same letter'(s) in each column are not significantly different at 5% level

IV. Vegetative growth parameters

1. Number of shoots per branch

In each season, both peanut shells and wood chips mulches with either 7 or 15cm thick layer had significant effect on number of shoots per branch (Table 4). Number of shoots per branch of "Anna" apple tree was found to be increased by peanut shells with 7cm thick layer followed in descending order by wood chips and peanut shells mulches with 15cm thick layer with each. Whereas, the lowest number of shoots per branch was found with trees grown under control treatment.

2. Number of leaves, leaf area per shoot and Shoot length

In both seasons, different organic OFMS had significant effect on both number of leaves and leaf area per shoot (Table 4). The highest values were produced by peanut shells mulch followed by 7cm thick peanut mulch but the difference was not significant among

them except number of leaves per shoot in the first season showed the significant differences. These results are in line with those of Shribbs and Skroch (1986) and Autio *et al*. (1991) on apple trees, who reported that wood chips mulch significantly increased number of leaves per shoot and leaf area. Furthermore, it is important to note that number of leaves and leaf area per shoot increased by increasing thick layer of mulch. Similarly, Granatstein *et al.* (2006 and 2014).

Data in connection with shoot length indicated that none of the treatment had significant effect on shoot length as clear in the first season (Table 4). Although, wood chips mulch with 15 cm thick layer had the longest shoot length (44.55 cm) compared to other treatments. However, in the second season, shoot length was significantly increased compared to control treatment and 15cm thick peanut shells mulch. Several researchers have shown an increase in shoot length of apple trees when organic mulch like wood chips was used (Treder *et al*., 2004; Hipps *et al.*, 2004; Edgars, 2005).

3. Shoot density

In the first season, wood chips mulch with either two layers was more effective on shoot density than peanut shells mulch (Table 4). In the second season, 7cm thick wood chips mulch recorded the minimum shoot density which was the only significant treatment. Such response has been demonstrated by several researchers (Treder *et al*., 2004; Hipps *et al*., 2004).

4. Tree volume (m^3)

In the first season, none of the treatments had significant effects on tree volume (Table 4). Although maximum tree volume with 15cm thick layer followed by peanut shells mulch with 7cm thick layer. In the second season, wood chips mulch with 15 cm thick layer was significantly increased tree volume compared to control (0.0 cm thick layer), but did not differ significantly from peanut shells mulch with either 7 or 15 cm thick layer. These results were similar to those reported by Szewczuk and Gudarowska (2004); Stefanelli *et al.* (2009); Solomakhin *et al.* (2012) and Kiprijanovski *et al*. (2019) they found that organic orchard floor management systems (*i.e.* wood chips, straw , pine bark, alfalfa hay, hard wood bark and saw dust) were significantly increased tree volume of apple.

5. Trunk cross sectional area (TCSA cm^2)

In both seasons, trunk cross sectional area (TCSA) was significantly influenced by different organic orchard management systems (Table 4). Maximum value of TCSA was recorded by peanut shells mulch with 15cm thick layer. The increase in TCSA of apple trees was due to increase in availability of soil moisture, nutrients and moderate evaporation from soil surface (Kumar *et al.*, 2014). These results go in line with those mentioned by Granatstein and Mullinix (2008); Granatstein *et al.* (2014) and Neilsen *et al.* (2014).

Table (4): Effect of different organic orchard floor management systems on vegetative growth of "Anna" apple trees during 2016 and 2017 seasons

Treatments		No. shoots/ branch	Shoot length (cm)	No. leaves/ shoot	Total leaf area/ shoot (cm^2) *	Shoot density (%) **	Tree volume (m^3)	TCSA (m^2) ***
Materials	**Thic. (cm)**							
2016								
P.S	**7**	4.31 A	43.59 A	32.48 B	914 A	0.025B	18.70 A	0.017 B
	15	3.56 AB	37.96 A	35.43 A	1004 A	0.020 B	17.29 A	0.023 A
W.C	**7**	3.25 B	42.37 A	30.82 B	715 B	0.034A	13.98 A	0.021 AB
	15	3.75 AB	44.55 A	32.37 B	670 B	0.037A	18.88 A	0.018 AB
Co.	**0**	3.87 AB	41.35 A	26.45 C	645 B	0.040A	16.27 A	0.021 AB
2017								
P.S	**7**	3.93 A	44.64 A	35.73AB	740 AB	0.036A	19.48A	0.027 AB
	15	3.50 ABC	35.86 BC	36.5 A	828 A	0.035A	16.81AB	0.032 A
W.C	**7**	2.93 C	40.42 ABC	30.38 C	649 BC	0.027 B	12.20AB	0.020 B
	15	3.56 AB	42.19 AB	32.30 BC	732 AB	0.036A	19.72 A	0.022 B
Co.	**0**	3.35 BC	35.62 C	25.02 D	578 C	0.037A	11.15 B	0.018 B

Values followed by the same letter'(s) in each column are not significantly different at 5% level.
Thic. = thickness of organic material, P.S= peanut shells, W.C= wood chips.
(*) = leaf area * (No. leaf / shoot)
(**) = (No. shoots / branch) / (branch length)

V. Yield attributes

1. Number of fruits per trees

In both seasons, organic OFMS had significant effect on number of fruits per trees (Table 5). However, 15cm thick wood chips mulch gave significant higher values than the other treatments during the first season but did not differ significantly from 7cm thick wood chips and 15cm thick peanut shells mulches in the second season. This increment in number of fruits may be due to increase number of flowers; fruit set and decreased the fruitlet abscission as reported by Fatemah Garah (1999); Szewczuk and Gudarowska (2004) and Pande *et al.* (2005) on sour cherries and "Red Delicious" apple. On the other hand, it could see that fruit numbers was significantly increased in either peanut shells or wood chips mulch by increasing thick mulch layer.

2. Fruit weight

Fruit weight was significantly increased by application of organic orchard floor management systems as compared to control treatment. The maximum fruit weight was recorded with wood chips when applied with 15cm thick layer. While, the lowest fruit weight was recorded in trees grown over unmulched treatment (control). This came in line with previous research in various crops when wood chips mulch was used (Granatstein and Mullinix, 2008; Granatstein *et al*., 2010; Nicholson 2012; and Kiprijanovski *et al.*, 2019).

3. Tree yield

Data in table 5 clearly indicated that, in both seasons, all treatments were significantly tended to increase tree yield over control. The highest tree yield was obtained with the use of wood chips with 15 cm thick layer followed by 7 cm thick wood chips mulch and 15cm thick peanut shells mulch with no significant differences between the latter two treatments. The increase in yield was mainly attributed to increase in soil temperature and availability of soil moisture for longer duration. Similar results of increased yield due to wood chips mulch were reported on apple by Neilsen *et al.* (2004); Treder *et al*. (2004); Edgars (2005); Granatstein and Mullinix (2008); Granatstein *et al.* (2010) and Solomakhin *et al.* (2012).

4. Yield efficiency

In the two seasons, different organic OFMS had significant effect on yield efficiency compared to control (Table 5). Significant higher yield efficiency was observed in trees grown over 15-cm thick wood chips mulch as evident in the first season compared with other all treatments and with (14.18 kg/cm^2) wood chips with 15cm thick layer in the second season. However, in the two seasons, minimum yield efficiency (3.91-7.53 kg/cm^2) was recorded under control treatment. The highest yield efficiency in trees grown over organic material mulches could be partly ascribed to the higher level of nutrients (Fallahi *et al.*, 2010) such as N, P and K in the leaves of "Anna" apple trees compared to control treatment. These results are in general accord with those of Becerril-Roman *et al*. (2004) who found that wood chips mulch increased yield efficiency of "Agua Nueva II" apple trees. In contrast, Kotze (2012) found that compost mulch reduced yield efficiency of "CrippsPink"appletrees.

Table (5): Effect of different organic orchard floor management systems on fruit numbers and weight, tree yield and yield efficiency of "Anna" apple trees during 2016 and 2017 seasons

Treatments		No. fruits/ tree	Ave. fruit weight (g)	Tree yield (kg)	Yield efficiency (kg/cm^2)
Materials	**Thickness (cm)**				
			2016		
Peanut shells	**7**	199.00 B	89.87 B	17.86 C	10.33 B
	15	173.00 C	123.34 A	21.36 B	9.58 B
Wood chips	**7**	185.00 BC	124.22 A	22.97 B	11.14 B
	15	215.75 A	125.02 A	26.96 A	15.36 A
Control	**0**	78.00 D	93.42 B	7.26 D	3.91 C
			2017		
Peanut shells	**7**	159.50 B	145.93 B	23.28 C	10.55 AB
	15	186.25 A	144.03 B	26.69 B	8.28 B
Wood chips	**7**	205.00 A	130.85 C	26.82 B	13.23 A
	15	190.00 A	160.24 A	30.33 A	14.18 A
Control	**0**	111.25 C	124.07 C	13.78 D	7.53 B

Values followed by the same letter'(s) in each column are not significantly different at 5% level

VI. Fruit quality

1. Shape index

In the first season, maximum value of fruit shape index (1.19) was observed with wood chips mulch applied in layer 15cm thick. In the second season, there were non- significant differences in fruit shape index due to application of various mulches, which varied from 1.17 to 1.11

2. Firmness (kg/cm^2)

In both seasons, fruit firmness was significantly affected by different organic mulches (Table 6). Peanut shells mulch by each thick layer improved fruit firmness than wood chips when applied in layers 7 and 15cm thick and control treatment.

3. Starch index

Data in Table 6 indicated that control treatment had higher value of starch index than the other treatments which failed to induce significant effect in this respect in both seasons. These results are in general accord with those of Van der Merwe (2012) who found that percentage starch breakdown was significantly more in the wood chips treatment compared to the control. The same result was also achieved when various material mulches such as pine bark and saw dust were applied under apple trees (Szewczuk and Gudarowska 2004; Solomakhin *et al*., 2012; Kiprijanovski *et al*., 2019). On the contrary, Treder *et al*. (2004) and Granatstein *et al*. (2014) who pointed out that organic mulches (e.g. wood chips, pine bark and saw dust) had not significant effect on starch index as compared to control.

4. Soluble solids content (SSC%)

The results of SSC of "Anna" apple fruits indicated in table 6 apparent that application of various organic mulches had significant effect on SSC during the two seasons. The maximum (8.6-10.1%) SSC was observed with effect of peanut shells mulch applied in layer 15cm thick. Whereas, the lowest (7.85-8.45%) SSC was recorded under control treatment. The same result was achieved by several researchers (Granatstein and Mullinix, 2008; Granatstein *et al*., 2010; Nicholson 2012; Kiprijanovski *et al.*, 2019) who shown an increase in SSC of apple and pear fruits when wood chips was used. However, conflicting results were noted by Treder *et al*. (2004), Szewczuk and Gudarowska (2004) and Granatstein *et al.* (2014) who pointed out that organic mulches such as wood chips, pine bark and saw dust had not significant effect on SSC.

5. Juice titratable acidity (TA%):

Acidity as influenced by different organic mulches has been presented in Table 6. However, the highest acidity (%) in "Anna" apple fruits was observed in control treatment followed by 7cm thick wood chips mulch, but the differences have not been found between them in the first season. While, 15cm thick wood chips mulch, in the second season, was only significant higher acidity than the other treatments which had nearly similar values. In this respect, wood chips mulch had significantly higher malic acid than control (Nicholson, 2012).

6. SSC/acid ratio

SSC/acid ratio was significantly affected by different organic orchard floor management systems (Table 6) where in the first season, the highest SSC/acid ratio was obtained by 15cm thick wood chips and peanut shells mulch, however in the second season, the highest value was obtained by 7 and 15 cm thick peanut shells mulch. Whereas, the lowest SSC/acid ratio was obtained by control in both seasons.

Table (6): Effect of different organic orchard floor management systems on fruit quality at harvest for "Anna" apple fruit during 2016 and 2017 seasons

Treatments		Fruit shape index	Firmness (kg/cm^2)	Starch index	SSC (%)	Acidity (%)	SSC / acid ratio
Materials	**Thickness (cm)**						
2016							
Peanut shells	**7**	1.09 B	2.80 A	6.16 B	7.55 D	524 B	1.44 C
	15	1.13 AB	2.66 AB	6.76 A	8.60 A	506 BC	1.69 A
Wood chips	**7**	1.12 AB	2.45 CD	6.26 B	8.53 A	562 A	1.51 B
	15	1.19 A	2.56 BC	6.16 B	8.41 B	502 C	1.67 A
Control	**0**	1.15 AB	2.42 D	6.77 A	7.85 C	569 A	1.37 D
2017							
Peanut shells	**7**	1.11 A	2.83 A	6.75 AB	9.71 B	569 B	1.70 A
	15	1.15 A	2.80 A	5.92 B	10.10 A	593 A	1.70 A
Wood chips	**7**	1.13 A	2.56 C	6.33 B	8.46 C	549 C	1.54 B
	15	1.11 A	2.73 AB	6.53 AB	8.43 E	553 BC	1.52 B
Control	**0**	1.17 A	2.62 BC	7.53 A	8.45 D	558 BC	1.51 B

Values followed by the same letter'(s) in each column are not significantly different at 5% level

CONCLUSION

The application with thicker layer of organic OFMS (wood chips and peanut shells) decreased soil temperature, increased soil moisture and was more effective in suppression weed growth. Peanut shells mulch increased number of leaves and leaf area per shoot while, 7 cm thick of peanut shells increased number of shoots per branch. However, both wood chips and peanut shells increased shoot length. Thicker layer of wood chips increased tree volume whereas thicker layer of peanut shells increased TCSA. As for "Anna" apple tree productivity, the thicker layer of wood chips increased number of fruits per tree, average fruit weight, fruit length, fruit shape index, tree yield and yield efficiency however, both wood chips and peanut shells increased fruit diameter while, 15cm thick of peanut shells increased soluble solids content (SSC).

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تأثير تغطية التربة بالمواد العضوية على النمو الخضري والإنتاجية وجودة الثمار لأشجار التفاح صنف "أنا"

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تم إجراء هذه الدراسة على موسمين متتاليين (٢٠١٦، ٢٠١٧) على أشجار تفاح صنف "أنا" عمرها ١٠ سنوات مروية بنظام الري بالتنقيط في البستان الخاص بشركة السادس من أكتوبر للمشروعات الزراعية. الإسماعيلية. مصر. وتهدف إلى دراسة تأثير تغطية التربة بنوعين مختلفين من المواد العضوية (قشر الفول السوداني ونشارة الخشب) بسمكيين مختلفين (٧ ، ١٥ سم) على خواص التربة، والنمو الخضري والإثمار وجودة الثمار لأشجار التفاح. تكونت التجربة من ٥ معاملات تم توزيعها في صورة قطاعات كاملة العشوائية. أدى زيادة سمك مادة التغطية العضوية (نشارة الخشب ، قشر الفول السوداني) إلى تقليل درجة حرارة التربة وزيادة محتوى التربة من الرطوبة ، وأدى أيضا إلى زيادة كفاءة مقاومة الحشائش. وأدى استخدام قشر الفول السوداني إلى زيادة عدد الأوراق والمساحة الورقية على الفرخ بينما أدى استخدام قشر الفول السوداني بسمك ٧سم إلى زيادة عدد الأفرخ / الفرع، وأدى استخدام كل من قشر الفول السوداني ونشارة الخشب إلى زيادة طول الفرخ. أعطى زيادة سمك المادة العضوية المستخدمة في التغطية زيادة إيجابية على حجم الأشجار، بينما أدى استخدام قشر الفول السوداني بسمك ١٥ سم إلى زيادة المساحة المقطعية للجذع. وأدى زيادة سمك المادة العضوية المستخدمة في التغطية إلى زيادة كل من عدد الثمار/الشجرة، ومتوسط وزن الثمرة، وطول وشكل الثمرة، ومحصول الشجرة والكفاءة المحصولية، وأدى استخدام كل من نشارة الخشب وقشر الفول السوداني لزيادة قطر الثمار، بينما أدى استخدام قشر الفول السوداني بسمك ١٥ سم إلى زيادة محتوى الثمار من المواد الصلبة الذائبة. وبالتالي فإنه يمكن التوصية بتغطية التربة أسفل أشجار التفاح بطبقة ذات سمك ١٥ سم من مواد التغطية العضوية وبصفة خاصة نشارة الخشب.