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Original Research Article

Response of Soil Properties, Growth, Yield and Fruit Quality of Cantaloupe Plants (*Cucumis melo* L.) to Organic Mulch

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Abstract

A modified greenhouse study was performed in summer season 2016 and 2017 to evaluate the effect of organic mulch on soil temperature, soil properties, vegetative growth, and total yield and its components for cantaloupe plants (*Cucumis melo* L.), 10411 F1 hybrids, at El-Bosialy site. Five types of organic mulches were used (chopped wheat straw, wood dust, chopped maize straw, rice straw, and chopped sugarcane straw) compared with bare soil as the control. Seedlings were transplanted in 1st of April 2016 and 2017. The experimental design was a randomized complete block with four replications. Results indicated as generally, the application of organic mulch treatments were the most effective in reducing maximum and minimum of soil temperature, improved soil properties (soil pH, soil organic matter, soil moisture content, soil bulk density, electrical conductivity and N. P. K. availability), enhanced vegetative development (plant height, total leaves area and fresh and dry weights of plant), improved percent of nitrogen, phosphorus, potassium, calcium and magnesium in leaves, gave greatest values of fruit characters such as (fruit average weight and firmness), increased chemical components of fruits, i.e., (T.S.S and ascorbic acid) and maximum productivity for both early and total yields, also, economic evaluation presented that productivity was increased by application organic mulches compared to bare soil. Finally, wheat straw treatment had the greatest effect of all parameters.

Keywords: Organic mulches, Soil properties, Cantaloupe plant and Economic evaluation.

INTRODUCTION

Cantaloupe fruit (*Cucumis melo* L.) is one of the most significant and popular fruity vegetables grown in Egypt, it's vital cucurbitaceae crop after watermelon and cucumber (Nu˜nez-Palenius *et al*., 2008). The fruits containing high amounts of phenolics, flavonoids, vitamins, carbohydrates, and minerals with very few amounts of fat and calories (Adeyeye *et al*., 2017).

Mulching is an agriculture practice of covering the soil surface. It reflected positively on the cultivated crops in lots of ways such as regulate soil temperature, weed control, reduce both of water loss and agrochemical leaching as well as protecting from soil dirt and diseases (Scarascia-Mugnozza *et al*., 2006).

From the side of climatology, mulching directly influence the microclimate around the plant by modifying the radiation resources of the surface and declining the soil water loss (Moursy *et. al*., 2015). However, it controls the changes in thermal and humidity conditions which influences the growth and improvement of plants and increases the yield of vegetables (Majkowska-Gadomska, 2010). Moreover, mulch reduced competition for light due to weed absence (Ricotta and Masiounas, 1991). Previous studies have shown an increased in soil moisture, and a significant decrease of daily average and maximum temperature under mulches, in particular under straw (Duppong et al., 2004). Different materials may be used for mulching, including crop residues and organic mulches (Masarirambi *et al*., 2013), various plastic materials, paper mulches, biodegradable films etc. (Haapala *et al*., 2014). Organic mulches derived from plant material, will decompose in time and develop the soil. This results in increased aeration and adds water holding capability (Gunasekaran and Shakila, 2014).

Moreover, mulching is an application of any plant residues or other materials for covering top soil surface for conserving soil moisture, reducing the runoff and thereby to manage soil erosion, checking weed growth, improving soil temperature, modifying the micro environment of soil to meet the needs of seeds for their good germination and better growth of seedlings (Chavan *et al*., 2010). Mulching decreases the fluctuations in temperature in the first 20- 30 cm depth in soils and promotes root improvement, reduces vegetative competition in the rooting zone, reduces fertilizer leaching and soil compaction, and the vegetable productions are cleaner since no soil is splashed onto the plants or fruits (Moreno *et al*., 2009).

All mulching types had numerous benefits on soil properties, and as a result increases water holding capacity (Teame, 2017), soil moisture status, improves structure of soil (Muhammad *et al*., 2009), enhanced availability of macro- and micro-nutrients (N, P and K) in soil (Ni *et al*., 2016), and soil organic matter increased (Ni *et al*., 2016; Teame, 2017) and significantly decrease on soil electrical conductivity (Khurshid *et al*., 2006; Kumar and Lal, 2012), soil pH (Duryea *et al.,* 1999) and soil bulk density. However, the massive use of agricultural plastics raises a number of challenges mainly in end of cycle management especially issues related to sustainability drawbacks and negative environmental impacts.

A large portion of plastic films is left on the field or burnt uncontrollably by the farmers, emitting harmful substances with the associated negative consequences to the environment (Scarascia-Mugnozza *et al*., 2006). Moreover, a broad variety of options among organic materials, each with distinct features and suitability for vary in increasing circumstances. In addition, to developing all soil properties, it does have some advantageous features such as having environmentally sound characteristics. Organic mulches are available and accessible on the farm as a crop residue, crop leave compost and etc (Ranjan *et al*., 2017).

The study aimed to determine the effect of soil covering with organic mulch (wheat straw, wood dust, corn straw, rice straw and sugarcane straw) plus bare soil on changes in soil temperature and moisture as well as on vegetative growth parameters and the yield and components of cantaloupe plants.

MATERIALS AND METHODS

The experiment was performed in the summer seasons of 2016 and 2017 at EL-Bosaily Protected Cultivation Site, Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center (ARC), 15 Km west of Rosetta.

The current study was conducted in single type unheated net house each of 360 m2 (9m width, 40m length, and 3.2m height) to investigate the soil temperature, soil properties, growth and productivity of cantaloupe plants (*Cucumis melo* L.), 10411 F1 hybrid under some types of organic mulch. Five types of organic mulches were used (chopped wheat straw, wood dust, chopped maize straw, rice straw, and chopped sugarcane straw) compared with bare soil as control.

The experimental net house was divided into five raised beds. Each ridge was 100cm width and 40 meters long. Seedlings were transplanted in 1st of April 2016 and 2017 at a spacing of 0.5m between plants inside the same raw. Chemical fertilizers were added according to the recommendation of the Ministry of Agriculture. Organic mulch (3 cm thickness) was used as soil mulch for tested crop. The beds were irrigated using drip irrigation system in which the dripping line was placed about 10 cm from the center of the seedbed.

Data recorded

Climatic conditions

The microclimate is a major factor in this study, thus the following data were recorded: (a) Air temperature: Maximum and minimum air temperatures of in and out net house were recorded by using digital thermo/hygrometer Art. No. 30.5000/30.5002 (Produced by TFA, Germany) placed at the middle net house. (b) Soil temperature: Maximum and minimum soil temperature at 10 cm soil depth was recorded by using a digital thermometer. The results were calculated as an average of every 10 days.

Soil properties

To determinate soil physical and chemical properties, soil samples were taken before the preparation.

a) Physical analysis:

This was determined using the international pipette method according to Piper (1950) and presented in Table (1-a). Moreover, soil Bulk density of 0-30 cm depth was determined by core method Black and Hartge (1986).

Table (1-a). Physical properties of the soil of the experiment before preparation.

Soil depth cm	Sand %	Clay %	Silt %	Texture	FC* %	PWP** %	Bulk density g/cm3
0-30	95.31	4.30	0.36	Sandy	16.77	5.65	1.57

*Field capacity (FC%) ** Permanent wilting point (PWP%)

Table (1-b). Chemical analyses of the soil at El-Bosaily site.

O.M (%)	ECe (dS/m)	pH	Available mg/kg			meq /l							
						Cations				Anions			
			N	P	K	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
0.54	1.55	7.67	213.35	9.45	124.78	3.5	2.0	8.07	1.17	0.0	1.5	9.0	4.24

$$\text{Soil Bulk density} = \frac{\text{Mass of oven-dry soil}}{\text{Volume of soil including pore spaces}}$$

b) Chemical analysis

(1) *Soil reaction* (pH): it was determined in soil water suspension (1:2.5) using pH meter, with a glass electrode, calcium carbonate content was determined volumetrically using collins calcimeter. (2) *Electrical conductivity* (Ec) as well as soluble ions: it was determined in soil paste extract as described according to Jackson (1967). (3) *Available nitrogen* was determined by Micro Kjeldahl Bremner and Mulvaney (1982) method; the available nitrogen (AN) was extracted with 1 M KCL and analyzed using the cadmium reduction method Dorich and Nelson (1984). (4) *Available phosphorus* was analyzed according to Olson and Sommers (1982). (5) *Available potassium* was measured by flame photometry Baruah and Barthakur (1997) method. (6) *Soil organic matter* (SOM) was determined by 'Walkely- Black' method Nelson and Sommers (1982). (7) *Soluble Na and K* were determined by flame photometer. However, soluble Ca and Mg were determined using versenta method and soluble anions, namely; Cl and HCO_3 were determined volumetrically according to Black (1981). Values of the mentioned investigated soil chemical properties are tabulated in Table (1a and b).

Soil moisture was determined when soil moisture was at field capacity level to crop use at 3 days of irrigation at 0-30 cm depths and the soil core samples were dried in an oven for 24 hours at 105°C Top and Ferre (2002). Using the following formula:

$$\text{Soil moisture \%} = \frac{\text{Fresh weight (field capacity) - Oven dry weight (24 hours at 105}^{o}\text{C)}}{\text{Oven dry weight}} \times 100$$

Vegetative growth

Plant height and number of leaves per plant were recorded at 25, 55 and 80 days after transplanting. Total leaves area was recorded at 25, 55 and 80 days after transplanting by using a digital leaf area meter (LI-300 Portable Area Meter Produced by LI. COR, Lincoln, Nebraska, U.S.A). Fresh and dry weights of the plant were recorded three times during the growth period, i.e., 25, 55 and 80 days from transplanting.

Yield and its components

(a) Fruit characters:

Representative samples of 5 fruits from fruit picking were collected to determine the following:

- Average of fruit weight.
- Fruit firmness (mg/m^2): measured at the mature stage by using Penetrometer (Fruit Pressure Tester) mod. FT 327.

(b) Early and total yield

Fruits were recorded for each harvest and the early yield was determined on the basis of the first two harvests. The total was recorded from the total harvest collections.

Chemical properties

Nitrogen was determined after 55 days from transplanting in leaves by the distillation in a Macro-Kjeldahle according to (FAO, 2008). Phosphorus was colorimetrically determined after 55 days from transplanting in leaves in the acid digest using ascorbic acid and ammonium molybdate as described by FAO (2008). Potassium was estimated after 55 days from transplanting in leaves photometrically as described by FAO, 2008. Total calcium and magnesium were determined after 55 days from transplanting in leaves spectrometrically using Phillips PU 9100 Atomic Spectrometer according to FAO (2008). Total soluble solids (T.S.S.) were determined in fruits by hand refractometer (A.O.A.C., 2000). Ascorbic acid content (vitamin C) was determined in the fresh fruits by using the 2, 6 Dichlorophenolindophenol method described in A. O. A. C. (2000).

Economic evaluation

Economic indicators were used to provide economic evaluation for this experiment.

Experimental design and data analysis

All treatments were arranged in a randomized complete block design with four replications. Obtained data were statistically analyzed using the analysis of variance method. Duncan's multiple range tests at 5% level of probability were used to compare means of the treatments (SAS, 2005).

RESULTS AND DISCUSSION

Climatic data

Data illustrated in Figure (1) showed maximum and minimum temperature at El-Bosaily site during summer 2016 and 2017 seasons. The greatest value of maximum air temperature was, in general, detected in outside of the net greenhouse. However, the lowest maximum air temperature was found inside plastic net houses. The mentioned trend was similar during both summer seasons. These findings are in accordance with those of Sandri *et al*. (2003), and Kittas *et al*. (2005). It concluded that the net greenhouse reduces both maximum and minimum air temperature compared with those of the outside. This could be due to the low radiation inside a net greenhouse compared to outside.

Soil temperature

Maximum and minimum soil temperature at El-Bosaily was presented in Figures (2 and 3). The illustrated data demonstrated that control treatment (bare soil) had the highest value of the maximum and minimum soil temperature followed in decreasing order by sugarcane straw treatment. However, the lowest maximum and minimum soil temperature were found with wheat straw treatment, followed by wood dust treatment.

These results are in agreement with results reported that retention of organic matter as mulch on the soil surface is one of the ways of decreases soil warming in summer months as well as helps to decrease fluctuations of soil temperature (Duppong *et al.*, 2004; Kosterna, 2014).

Moreover, Mulching reduces soil temperature in summer. Mulches are known to expand the dirt temperature since the sun's vitality goes through the mulch and warms the air and soil underneath the mulch specifically and after that, the warmth is caught by the "nursery impact". On the off chance that Top soil temperature is intemperate, mulching can lessen temperature for increasingly ideal germination and root advancement. It prevents the extremes of temperatures. Mulch reduces water evaporation from soil and help to maintain stable soil temperature (Kar and Kumar, 2007).

In addition, temperature limits will kill fine roots and whereas hardly ever killing reputable plantings, they can induce chronic stress as the plant expends energy to produce new fine roots. Temperature modification is especially important near the soil surface, where fine roots can be killed (Goulet, 1995). Hot surface soils can kill new transplants that have not had time to generate a large root mass and establish into deeper, more moderate, surrounding soils (Chalker-Scott, 2007).

During summer, mulching conserves the soil moisture due to abridged disappearance. The cooling effect of soil promotes root expansion. In general, the effect of mulching on the temperature management of the soil varies according to the ability of the mulching material to reflect and transmit solar energy. Mulches result in superior water content and lower the evaporation. However, effects on soil temperature are highly variable. White mulches decrease soil temperature, as well as wheat straw mulch, raised the soil temperature by 2–3°C (Kumar and Lal, 2012). The prevention of direct contact of solar radiation with the soil by the organic mulches explains the low soil temperature Awodoyin *et al.*, 2007.

The mulches used in this experiment may have lowered temperature making it favorable for plant growth Mathew and Karikari (1990). Mulches can have a temperature change effect of 0.5-3°C (Zhao, 2012) depending on conditions.

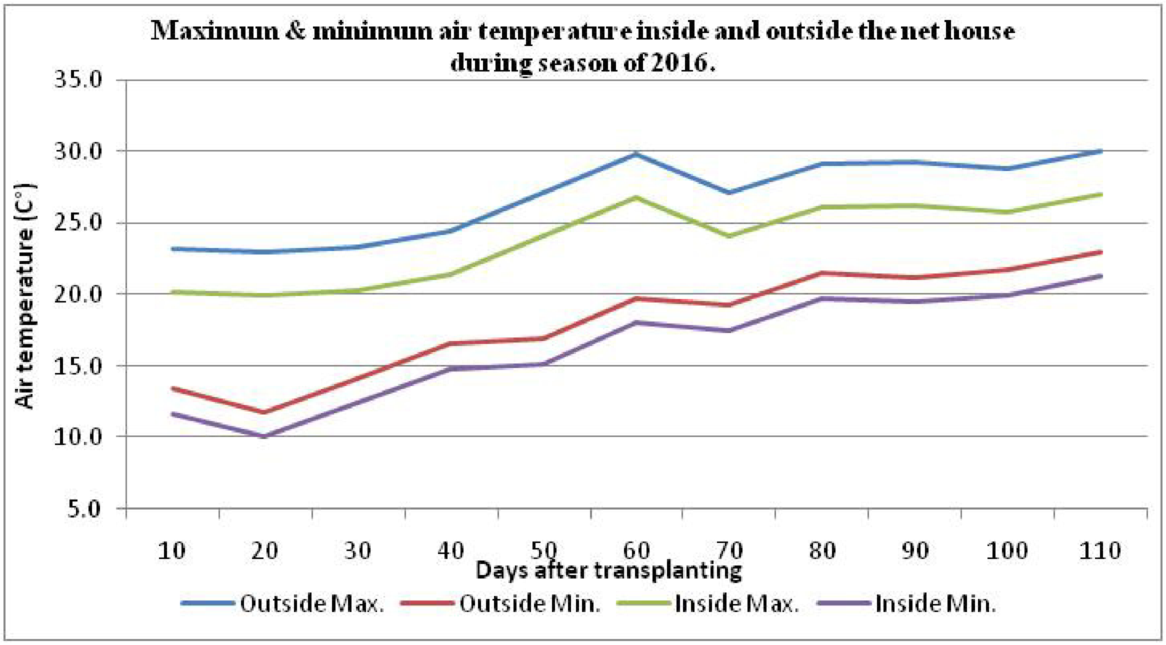
Soil properties

Soil reaction (pH)

Data presented in Table (2) indicated that organic mulch treatments did not reflect any significant effect on the soil pH in both tested seasons. Although, the lowest soil values of pH were observed with wheat straw treatment followed by wood dust treatment. Whereas, the highest soil pH values were recorded at bare soil treatment. Moreover, the drop in pH attributed to the effect of acidic organic mulch application lead to decreases soil pH compared to control treatment. In addition, this reduction in soil pH probably due to significant improvement in the soil organic matter and exchangeable cations, while, the slight increase of pH at un-mulched could be attributed to erosion losses from the top soil. Leaching can also, be another factor leading to the raise in pH. These results are agreement with (Duryea *et al.*, 1999).

Soil organic matter (SOM)

Data in Table (2) showed that the greatest values of soil organic matter (SOM) were obtained with applied wheat straw treatment followed in disorder by maize straw and



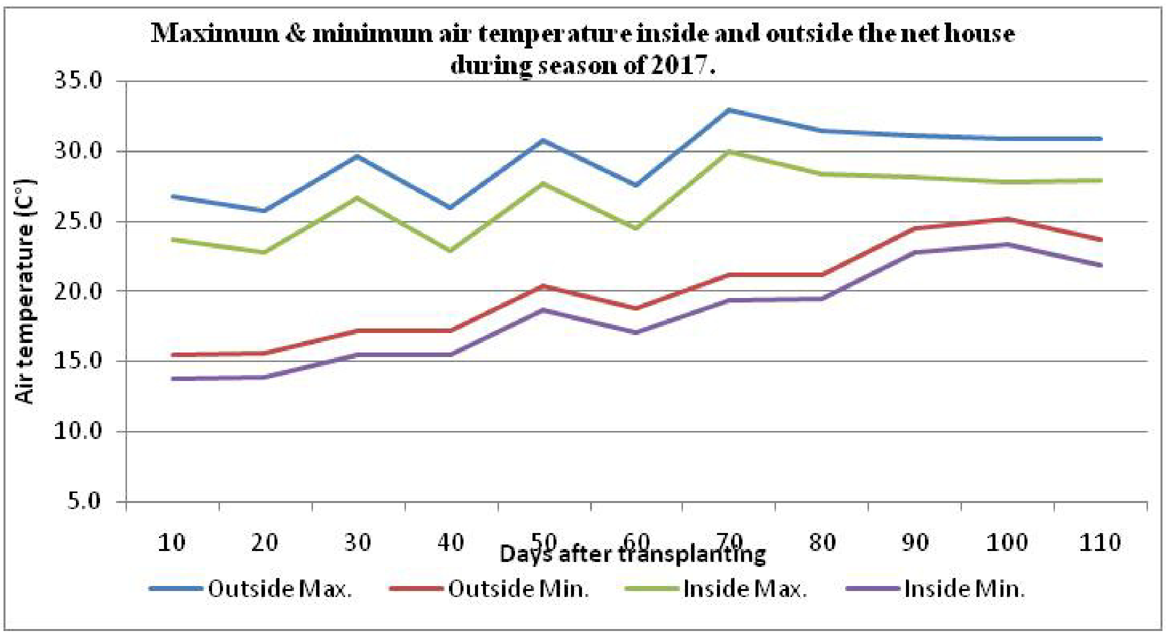
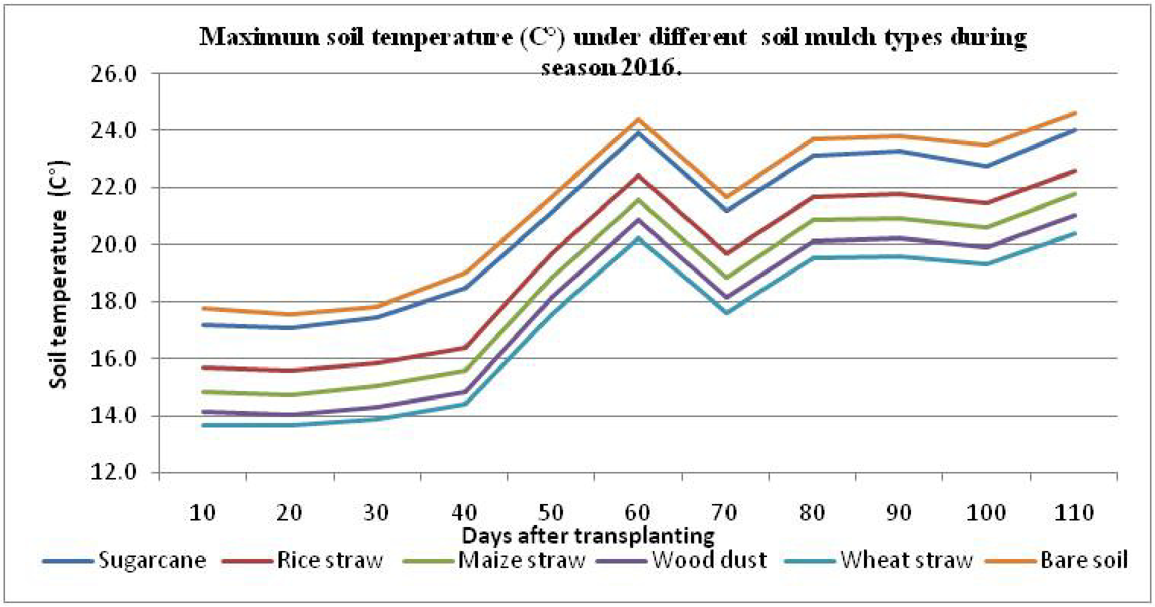


Figure 1. Maximum and minimum air temperature inside and outside the net house during seasons 2016 and2017.



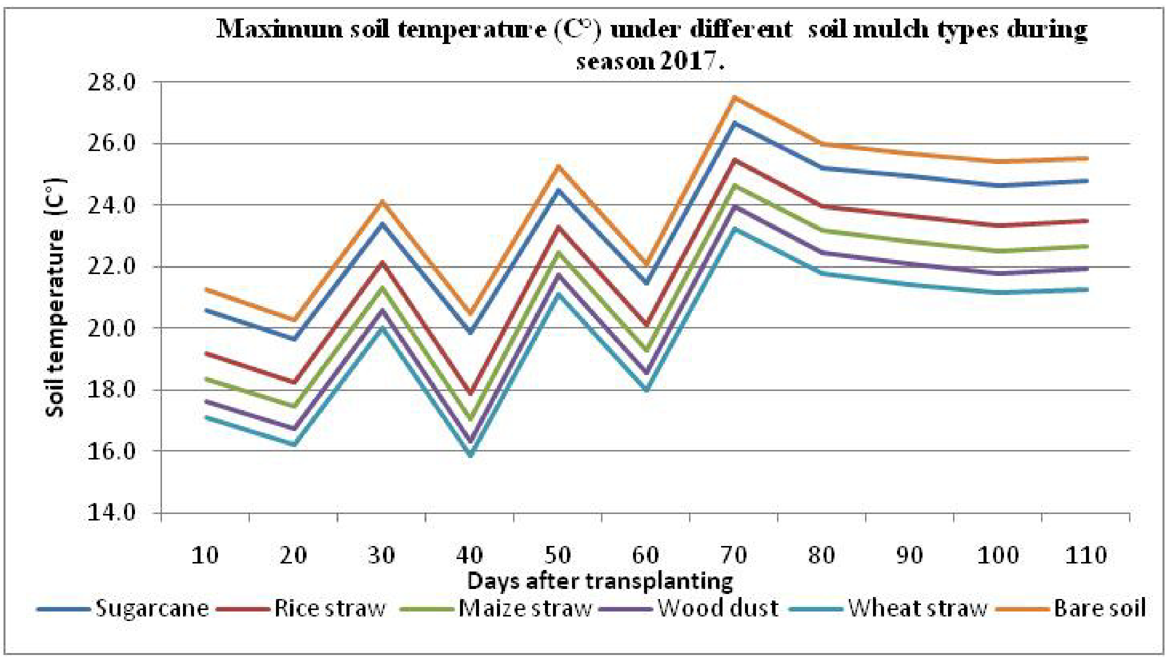
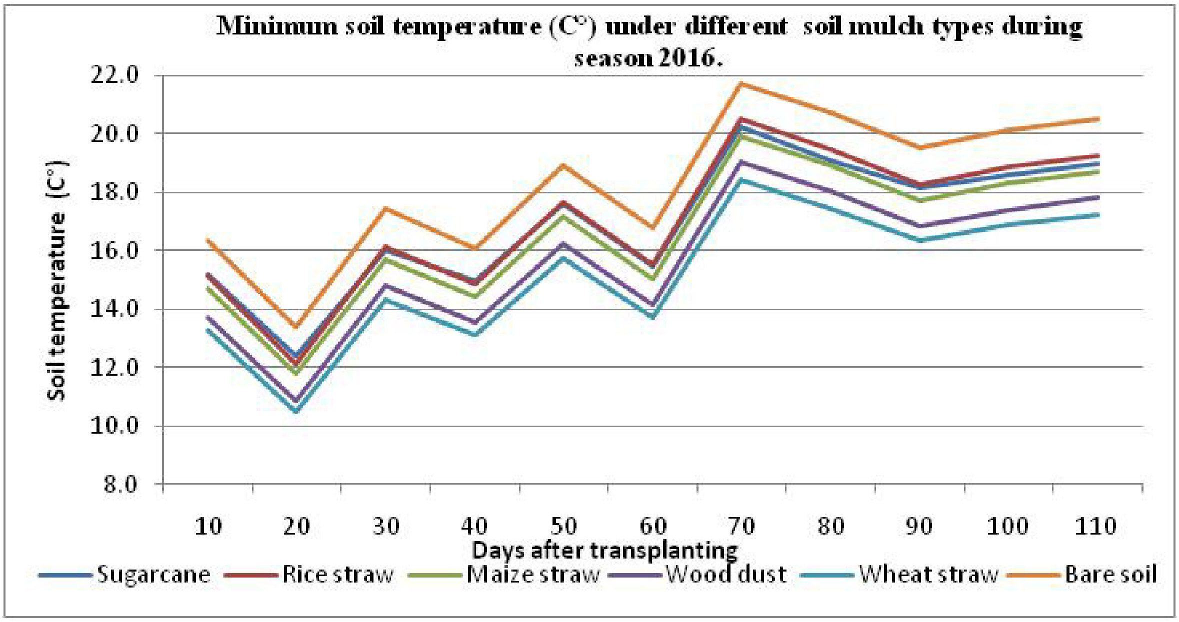


Figure 2. Maximum soil temperature (C°) under different soil mulch types during seasons 2016 and 2017.



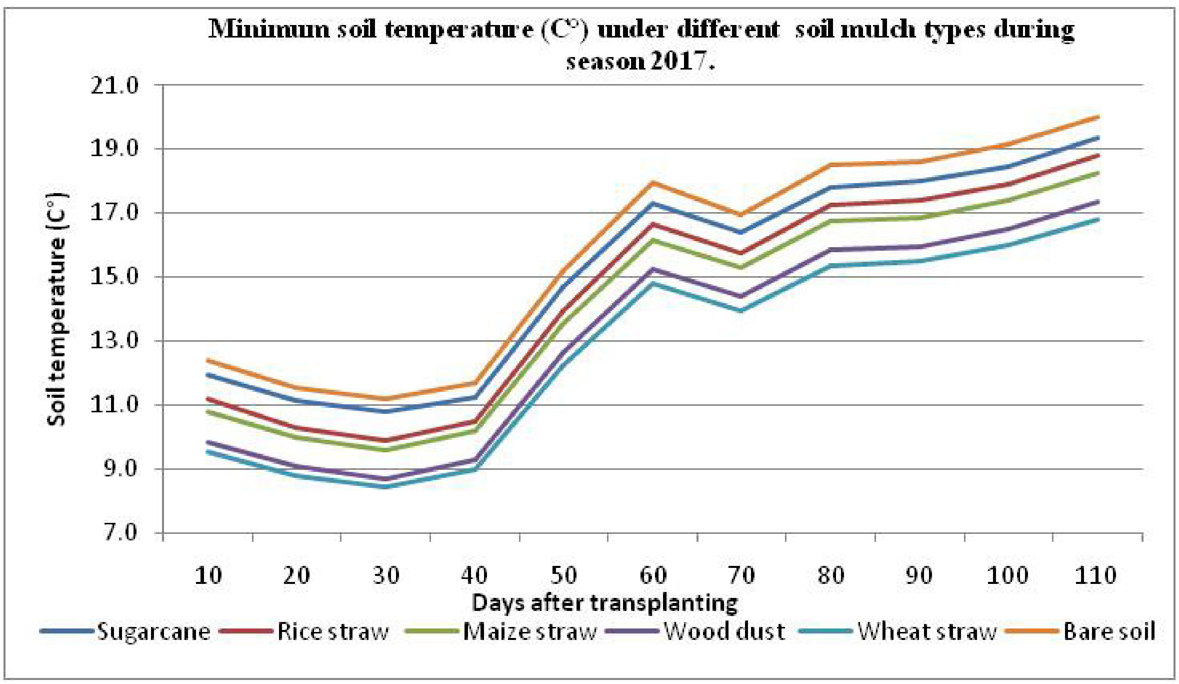


Figure 3. Minimum soil temperature (C°) under different soil mulch types during seasons 2016 and 2017.

wood dust treatments, respectively. While bare soil treatment gave the lowest values. The mentioned trend was true all over two growing seasons. These results are in agreement with (Ni *et al*., 2016). Who reported that organic mulch increased SOM content in soil after decomposition and mineralization.

Soil Bulk density (SBD)

Data in Table (2) showed the significant effect of organic mulch application on soil bulk density (SBD). Highest values were observed with bare soil treatment when the lowest values obtained with wheat straw treatment. This reduction due to decomposition, this led to improve and increase soil aggregation and porosity. These results are in harmony with (Teame, 2017).

Soil moisture content (%)

Table (2) noticed that soil moisture content (%) affected

Table 2. Effect of different types of organic mulch on soil pH, soil organic matter, soil Bulk density and soil moisture content during 2016 and 2017 seasons.

Treatments	pH	SOM (%)	Bulk Density (gcm^{-3})	Soil moisture (%)
		First season		
Wheat straw	7.57^{a}	0.68^{a}	1.42^{c}	18.3^{a}
Wood dust	7.58^{a}	0.61^{b}	1.48^{b}	17.7^{b}
Maize straw	7.63^{a}	0.63^{b}	1.45^{bc}	17.3^{c}
Rice straw	7.65^{a}	0.60^{b}	1.47^{b}	17.2^{c}
Sugarcane straw	7.65^{a}	0.56^{c}	1.48^{b}	16.8^{d}
Bare soil	7.66^{a}	0.50^{d}	1.55^{a}	16.7^{d}
		Second season		
Wheat straw	7.55^{a}	0.65^{a}	1.43^{d}	17.91^{a}
Wood dust	7.59^{a}	0.60^{bc}	1.49^{b}	17.29^{b}
Maize straw	7.65^{a}	0.62^{b}	1.45^{cd}	17.12^{b}
Rice straw	7.66^{a}	0.5^{c}	1.48^{bc}	16.89^{c}
Sugarcane straw	7.66^{a}	0.56^{d}	1.48^{bc}	16.64^{d}
Bare soil	7.67^{a}	0.52^{e}	1.56^{a}	16.59^{d}

significantly by applied organic mulch. Found that soil moisture content had slightly increased with organic mulch treatments compared with bare soil treatment. The highest soil moisture content was conserved at wheat straw treatment, followed by wood dust treatment, and whereas, the lowest value was conserved at sugarcane straw treatment followed in disorder by bare soil treatment. The results indicated the highest soil moisture values recorded in response to organic mulch, It may be due to mulches were used as a layer on soil surface reduced the rate of evaporation, hence, the soil moisture retained for a long time in soil. Similar results were observed by (Depar *et al*., 2014), who reported that soil moisture increased with applied organic mulch, especially, wheat straw mulch. Soil moisture content was significantly higher after organic mulching than that in the un-mulched control treatment during the experimental period (Ni *et al*., 2016).

Furthermore, mulch protects the soil from direct rays of the sun which would cause fading of moisture from the soil surface and cause drying of the soil profile. This leads to improved and higher soil moisture. According to Dilipkumar *et al*. (1990), mulching reduces soil water evaporation. Thus, it enhances more retention of soil moisture. Moisture retention of soil has been shown to be improved by the application of organic mulches.

Natural mulches helped to keep soil moisture content longer than exposed soil. Mulching conserves water by dropping evaporation and mitigates the negative effects of water stress on plant growth and yield under semi-arid conditions. Mulching conserves moisture contents which in turn results in increase in the plant growth (Nasir *et al*., 2011).

Soil electrical conductivity (Ec) and N. P. K. availability

Soil electrical conductivity and N. P. K. availability content were affected positively by application organic mulch in both growing seasons Table (3). Found that soil electrical conductivity and N. P. K. availability content had slightly increased with applied organic mulch treatments. On the other hand, the highest values of soil electrical conductivity and soil available N, P, and K. contents were observed with wheat straw treatment. Those increases were due to decomposing of organic mulch under appropriate nutrients, which, released to the soil and become available for plant (Chalker-Scott, 2007). These results are similar to (Ni *et al*., 2016). In addition, Pakdel *et al*. (2013) reported that, organic mulches are significantly affecting the soil electrical conductivity, available nitrogen, phosphorus, and potassium content.

On the other hand, organic mulches revisit the organic matter and plant nutrients to the soil and develop the physical, chemical and biological properties of the soil after decomposition, which in turn increases crop yield. Soil under the mulch remains loose and friable. Aeration and soil microbial activity is enhanced. In heavy black soil also, application of organic mulches decreased the bulk density over control. The organic mulches not only conserve the soil moisture, but they also increase the soil nutrients through organic matter addition. Organic mulches have the advantage of being biodegradable (Kumar and Lal, 2012).

Mulching improved soil moisture, organic matter contents leading to suitable environment for root penetration. Ghuman and Sur (2001) accomplished that mulching decreases bulk compactness of the surface soil. The soil organic matter increased due to decomposition of applied mulch. Khurshid *et al*. (2006) concluded that organic matter was significantly higher when more mulch was applied. Muhammad *et al*. (2009) observed that mulched treatments showed a significantly greater total uptake of nitrogen, phosphorus, and potassium than corresponding un-mulched ones.

Table 3. Effect of different types of organic mulch on soil electrical conductivity (Ec) and N. P. K. availability content during 2016 and 2017 seasons

Treatments	Ec (dSm^{-1})	N Available (mg/kg)	P Available (mg/kg)	K Available (mg/kg)
		First season		
Wheat straw	1.66[a]	305.2[a]	10.72[a]	173.3[a]
Wood dust	1.61 [b]	236.5 C	8.99 C	131.7[d]
Maize straw	1.58[bc]	280.0[b]	9.92[b]	159.1[b]
Rice straw	1.56[c]	241.8[c]	9.70[b]	149.6[c]
Sugarcane straw	1.60[b]	239.3[c]	9.84[b]	162.8[b]
Bare soil	1.52[d]	217.2[d]	8.43[d]	122.4[e]
		Second season		
Wheat straw	1.65[a]	295.34[a]	9.95[a]	169.16[a]
Wood dust	1.61[b]	224.75[c]	8.83[c]	129.56[c]
Maize straw	1.57[bc]	275.12[b]	9.75[ab]	155.93[b]
Rice straw	1.56[c]	234.77[c]	9.32[c]	136.79[c]
Sugarcane straw	1.59[bc]	228.25[c]	9.62[b]	158.41[b]
Bare soil	1.50[d]	206.70[d]	8.39[e]	117.68[d]

Table 4. Effect of different types of organic mulch on plant height (cm) and number of leaves of cantaloupe plants during 2016 and 2017 seasons.

Treatments	Plant height			Number of leaves		
	25	55	80	25	55	80
				First season		
Wheat straw	108.3[a]	209.3[a]	291.9[a]	41.1[a]	59.8[a]	71.0[a]
Wood dust	89.2[b]	187.6[b]	269.0[b]	36.7[a]	54.7[ab]	65.8[ab]
Maize straw	67.0[c]	169.5[c]	257.8[c]	28.0[b]	50.5[bc]	61.9[ab]
Rice straw	44.1[e]	153.7[d]	243.7[d]	20.0[c]	45.3[cd]	58.6[bc]
Sugarcane straw	39.4 [e]	143.8[d]	232.5[e]	17.3[c]	40.0[d]	48.3[cd]
Bare soil	51.4[d]	128.1[e]	197.6[f]	10.0[d]	31.7[e]	44.8[d]
				Second season		
Wheat straw	105.0[a]	203.0[a]	284.6[a]	37.2[a]	46.7[a]	54.5[a]
Wood dust	85.0[b]	182.1[b]	266.2[b]	33.2[a]	43.4[ab]	49.4[ab]
Maize straw	62.6[c]	163.3[c]	249.1[c]	25.7[b]	33.6[bc]	43.6[ab]
Rice straw	38.8[e]	149.0[d]	235.1[d]	17.9[c]	29.6[cd]	36.0[bc]
Sugarcane straw	37.7[e]	138.7[d]	223.1[e]	15.5[c]	21.8[d]	30.6[cd]
Bare soil	47.6[d]	124.5[e]	203.1[f]	8.0[d]	15.7[e]	21.0[d]

Plant height

Data in Table (4) showed that the highest value of plant height was observed with application wheat straw treatment followed by wood dust treatment at 25, 55 and 80 days from transplanting. While, the lowest values were noticed with sugarcane straw and rice straw treatments, respectively, without any significant differences at 25 days from transplanting. In addition, after 55 and 80 from transplanting the bare soil (control treatment) recorded the lowest values of plant height. The mentioned trend was true all over the growing seasons. These results are in agreement with those reported by (Awodoyin *et al.*, 2007). Who found that covering the soil surface with mulch significantly increased plant height compared with bare soil, which might be due to the increased soil temperature and observations on plant growth showed that the plants mulched plots were generally tall and more vigorous than in the un-mulched plots.

Number of leaves

Illustrated data in Table (4) presented the effect of organic mulch on the number of leaves. Highest values found with wheat straw and wood dust treatments, respectively, with unimportant differences after 25, 55 and 80 from transplanting, except, in the second season after 80 days from transplanting treatments of wheat straw, dust wood, and maize straw, respectively, gave the highest values of leaves number. Whereas, plants in bare soil treatment gave the low value of a number of leaves after 25, 55 and 80 days from transplanting, except, 80 days from transplanting, in the second

Table 5. Effect of different types of organic mulch on total leaves area (cm^2) of canteloupe plants during 2016 and 2017 seasons.

Treatments	25	55	80
		First season	
Wheat straw	9358.6^{a}	18056.7^{a}	27085.0^{a}
Wood dust	8456.0^{b}	16885.8^{b}	25328.7^{b}
Maize straw	7775.3^{c}	15812.0^{c}	23718.0^{c}
Rice straw	7081.7^{d}	14882.9^{d}	22324.3^{d}
Sugarcane straw	6224.2^{e}	12520.2^{e}	18780.3^{e}
Bare soil	5776.5^{f}	11081.9^{f}	16892.3^{f}
		Second season	
Wheat straw	9111.6^{a}	17536.8^{a}	26135.0^{a}
Wood dust	8246.1^{b}	16492.7^{b}	24729.7^{b}
Maize straw	7563.5^{c}	15213.4^{c}	23105.4^{c}
Rice straw	6916.1^{d}	14498.1^{d}	21721.1^{d}
Sugarcane straw	6099.1^{e}	12148.7^{e}	18200.9^{e}
Bare soil	5605.7^{f}	10856.5^{f}	16562.5^{f}

Table 6. Effect of different types of organic mulch on plant fresh and dry weight (g) of canteloupe plants during 2016 and 2017 seasons.

Treatments	Plant fresh weight			Plant dray weight		
	25	55	80	25	55	80
			First season			
Wheat straw	259.9^{a}	388.6^{a}	471.8^{a}	25.3^{a}	94.5^{a}	126.5^{a}
Wood dust	229.7^{b}	353.8^{b}	433.8^{b}	22.4^{b}	86.5^{b}	112.4^{b}
Maize straw	208.5^{c}	320.6^{c}	397.6^{c}	19.1^{c}	79.0^{c}	97.0^{c}
Rice straw	192.2^{cd}	289.4^{d}	358.9^{d}	16.3^{d}	72.4^{cd}	90.1^{cd}
Sugarcane straw	185.8^{d}	270.1^{d}	335.0^{e}	14.4^{e}	67.3^{d}	86.7^{d}
Bare soil	164.5^{e}	233.9^{e}	290.1^{f}	12.5^{f}	55.7^{e}	78.9^{e}
			Second season			
Wheat straw	252.8^{a}	383.3^{a}	461.6^{a}	24.6^{a}	92.5^{a}	123.2^{a}
Wood dust	225.8^{b}	347.3^{b}	423.6^{b}	22.0^{b}	84.6^{b}	109.9^{b}
Maize straw	202.6^{c}	311.7^{c}	389.0^{c}	18.8^{c}	77.3^{c}	94.9^{c}
Rice straw	189.4^{d}	281.5^{d}	349.1^{d}	16.0^{d}	70.8^{d}	88.1^{d}
Sugarcane straw	179.2^{e}	260.4^{e}	331.1^{e}	14.1^{e}	65.9^{d}	81.2^{e}
Bare soil	160.0^{f}	228.6^{f}	282.8^{f}	12.2^{f}	54.5^{e}	79.2^{e}

season, observed that sugarcane and bare soil treatments recorded the lowest values without any significant differences. These finding are in accordance with (Norman *et al*., 2011), who reported that, the organic mulch influenced significantly number of leaves/plant than the control (bare soil) treatment.

Total leaves area

Indicated data in Table (5) showed that total leaves area were affected significantly by applied organic mulch treatments compared with bare soil (control treatment). Wheat straw treatment gave the highest values for this parameter after 25, 55 and 80 days from transplanting. On the other hand, the lowest values obtained with control treatment at the same period of data recorded.

The results are true in both growing seasons. These results are in harmony with (Masarirambi *et al*., 2013), mentioned that leaf area was relatively higher in plants mulched when compared to plants un-mulched.

Plant fresh weight

Data in Table (6) presented as generally, the application of organic mulch increased plant fresh weight during experiment duration. The greatest values of plant fresh weight experiential with wheat straw treatment followed by wood dust treatment after 25, 55 and 80 days from transplanting. When plants grown in bare soil treatment gave the lowest values in the same period. This trend was true in both tested season. These results are in agree with Hong *et al*. (2001), who found that the foliage weight was higher with mulching materials than control. Mulching with residues and reflective film stimulate foliage growth. Matsenjwa (2006) reported that organic mulches increased vegetative growth.

Table 7. Effect of different types of organic mulch on leaves contents of N, P, K, Ca, and Mg (%) of cantaloupe plants during 2016 and 2017 seasons.

Treatments	N	P	K	Ca	Mg
			First season		
Wheat straw	5.427[a]	0.890[a]	6.1[a]	2.505[a]	1.082[a]
Wood dust	4.243[b]	0.732[b]	5.9[a]	2.360[b]	0.939[b]
Maize straw	3.903[c]	0.605[c]	5.6[b]	2.215[c]	0.802[c]
Rice straw	3.570[d]	0.481[d]	5.4[b]	2.151[cd]	0.745[c]
Sugarcane straw	3.333[d]	0.496[d]	5.0[c]	2.056[d]	0.739[c]
Bare soil	3.013[e]	0.431[d]	4.2[d]	1.817[e]	0.606[d]
			Second season		
Wheat straw	5.310[a]	0.963[a]	5.9[a]	2.451[a]	1.059[a]
Wood dust	4.152[b]	0.717[b]	5.8[a]	2.309[b]	0.919[b]
Maize straw	3.819[c]	0.592[c]	5.4[b]	2.167[c]	0.785[c]
Rice straw	3.493[d]	0.471[d]	5.3[b]	2.105[cd]	0.729[c]
Sugarcane straw	3.261[d]	0.486[d]	4.9[c]	2.011[d]	0.723[c]
Bare soil	2.949[e]	0.421[e]	4.2[d]	1.778[e]	0.593[d]

Plant dry weight

Presented data in Table (6) obtained that plant dry weight affected considerably by relevance to organic mulch treatments. From data in Table (6) noticed the highest values of plant dry weight recorded with wheat straw treatment followed respectively by wood dust treatment 25, 55 and 80 from transplanting. While, the lowest value indicated with bare soil treatment at 25, 55 and 80 days from transplanting. But, in second season, sugarcane straw treatment followed by bare soil treatment gave the lowest value after 80 days from transplanting was no statistical difference between both two treatments. These results were true in the first and second seasons. The obtained results are in harmony with Kumar *et al*. (2014) who found that dry weight (g/plant) was significantly higher in plots mulched with organic mulch because organic mulch improves aggregation of soil through high amount of organic matter in the form of leaf biomass (Gupta *et al*., 2009). Beneficial effects of mulching on growth and dry matter production have also been reported by Das (1999). Moreover, Kumar and Lal (2012) indicated increased plant dry weight for mulched plants is due to the capabilities of mulch to maintain soil moisture as well as increased efficiency in water uptake by plants.

From the Previous data on plant growth, it could be summarized that the organic mulch treatments were the most favorable application for stimulating plant growth expressed as plant height, a number of leaves, total leaves area and fresh and dry weights of the plant compared to bare soil. The favorable effect of the organic mulch on increase overall plant growth performance may be due to, mulched plants grow better than those grown on bare soil (Chalker-Scott, 2007). Many others have shown similar improvements in growth plant materials in field conditions (Singh and Singh, 1999). Specifically, increases in plant height (Cahill *et al*., 2005) and leaf size and/or number (Downer and Hodel, 2001) have all been reported as a result of mulching with appropriate materials. The best mulches for overall plant performance are organic materials, consistently rated as the best or second best in comparative field trials. Tested mulches include rapid decomposers such as grass clippings, leaves, and compost (Tilander and Bonzi, 1997), moderate decomposers including paper, hay and straw and other crop residues and slow decomposers, especially bark and woody chips (Downer and Hodel, 2001).

The effects of mulches on plants are operative through the effects of mulches on soil water, soil temperature structure. Reduced evaporation is a major reason for the growth of the plants due to mulch. Mulching provides a favorable environment for growth. A combination of the above, and perhaps other factors, results in more vigorous, healthier plants. Therefore, mulched plants usually grow and mature more uniformly than un-mulched plants. It was observed that different mulching materials highly influenced the growth characteristic. Increase in soil temperature and moisture content stimulate root growth which leads to greater plant growth Barman *et al*. (2005), Chawla (2006).

Chemical contents of leaves

Recorded data in Table (7) show the effect of different type of organic mulch on leaf contents of N, P, K, Ca, and Mg percentage. Generally, organic mulch application increased the percentage of N, P, K, Ca, and Mg in leaf after 55 days from transplanting. Wheat straw treatment gave the highest values percentage from N, P, K, Ca, and Mg, followed by wood dust treatment. Except for leaf content from K, both wheat straw and wood dust treatments, respectively, recorded the highest content leaf value from K without any significant differences. This result was true in both growing seasons. Although, bare

Table 8. Effect of different types of organic mulch on number of fruit/plant, average fruit weight/plant, early yield/plant, total yield of cantaloupe plants during 2016 and 2017 seasons.

Treatments	Number of fruit/plant	Average fruit weight/g	Early yield/plant/g	Total yield/Plant/g
		First season		
Wheat straw	4.2[a]	1221.7[a]	1282.3[a]	5129.2[a]
Wood dust	3.4[b]	993.0[b]	844.0[b]	3375.9[b]
Maize straw	3.1[b]	805.3[c]	617.4[c]	2469.5[c]
Rice straw	2.7[c]	657.0[d]	437.4[d]	1749.7[d]
Sugarcane straw	2.3[d]	586.0[e]	337.0[e]	1348.0[e]
Bare soil	1.9[e]	519.7[f]	246.8[f]	987.1[f]
		Second season		
Wheat straw	4.1[a]	1204.4[a]	1254.7[a]	5018.9[a]
Wood dust	3.3[b]	973.0[b]	825.8[b]	3303.3[b]
Maize straw	3.0[b]	788.0[c]	604.1[c]	2416.4[c]
Rice straw	2.6[c]	642.9[d]	428.0[d]	1712.0[d]
Sugarcane straw	2.3[c]	573.4[e]	329.8[e]	1319.1[e]
Bare soil	1.9[d]	508.5[f]	241.5[f]	965.8[f]

Table 9. Effect of different types of organic mulch on T. S. S., fruit firmness and ascorbic acid content of cantaloupe plants during 2016 and 2017 seasons.

Treatments	T.S.S (%)	Fruit firmness (mg/m^2)	Ascorbic acid content (mg/100g)
		First season	
Wheat straw	12.9[a]	1317[a]	28.706[a]
Wood dust	12.1[b]	1150[b]	27.697[b]
Maize straw	11.3[c]	1000[c]	27.255[c]
Rice straw	11.0[c]	890[d]	27.249[c]
Sugarcane straw	10.7[c]	780[e]	26.822[d]
Bare soil	9.7 [d]	647[f]	26.443[e]
		Second season	
Wheat straw	12.6[a]	1223[a]	27.773[a]
Wood dust	11.7[b]	1030[b]	26.864[b]
Maize straw	11.0[c]	927[c]	26.322[c]
Rice straw	10.8[c]	843[d]	26.348[c]
Sugarcane straw	10.4[c]	730[e]	25.588[d]
Bare soil	9.3[d]	580[f]	25.410[e]

soil treatment was given the lowest values of N, P, K, Ca, and Mg percentage in leaf. Moreover, in the first season, sugarcane straw, rice straw and bare soil treatments, respectively, observed the low values of P percentage in leaf with insignificant differences. These results were true during the growing seasons. Similar results were reported by Kumar *et al*., 2014. Also, Muhammad *et al*., 2009 observed that mulched treatments show significantly greater total uptake of nitrogen, phosphorus and potassium than corresponding un-mulched ones.

The stunted performance observed under mulch is due to immobilization of soil N by the soil microbes caused by high C: N ratio. Organic mulches improved soil nutrients, structure (Opara-Nadi, 1993). The decomposition of the organic mulch makes for higher nutrient availability and increased the soil organic matter for the plants' use. Rose (1996) reported that straw, wood-chips and sawdust mulches have a high carbon to nitrogen ratios.

Moreover, mulches with relatively high nitrogen content often result in higher yields Tilander and Bonzi (1997), low nitrogen mulches can also increase soil fertility and plant nutrition. For example, straw (Szwedo and Maszczyk, 2000), sawdust (Arthur and Wang, 1999), mulches have been shown to increase nutrient levels in soil and/or foliage. Likewise, mulches of husks were most effective in increasing available soil nutrients compared to grasses and leaf-litter Singh and Singh (1999), which presumably would have higher nitrogen levels.

Yield and its components

Illustrated data in Tables (8 and 9) presented the effect of application organic mulch on yield and components of cantaloupe crop. Data obtained that application of wheat straw treatment increased the number of fruit/plant, average fruit weight/plant, early yield/plant, total yield per plant, fruit firmness and fruit contents i.e., (T. S. S. and vitamin C) more than control treatment. Whereas, bare soil treatment indicated that the lowest values of those parameters. These findings were true during the two growing seasons. The obtained results are coincided with those of (Awodoyin *et al*., 2007; Alenazi *et al*., 2015). Mentioned that the increase of fruit yield affected by mulch that was higher and an indication that mulching is more beneficial to crop performance. Generally, mulches always increased yield traits when compared to the non-mulch application.

On the other hand, the yield and chemical composition were found to be improved. The yield and keeping quality of vegetables may be improved by straw mulch. This is probably due to better plant growth which is governed by soil temperatures with least fluctuations, and soil moisture as well. The increased yield significantly due to better soil moisture retention, a creation of favorable soil temperature, improved soil structure, elevated status of nutrient in soil and well development of root system (Kumar and Lal, 2012). Chen and Katan (1980) have reported a significant increase in vegetation and yield of different crops using mulch. Yield increase may be attributed to more favorable soil moisture and nutrient utilization.

The most common retort to mulch is an amplify in total yield. Marketable fruit yield from the mulched plot was considerably higher than those created on bare soil. This difference can be attributed to moisture conservation, higher soil temperature, and increased mineral nutrient uptake in the mulched plot through improved root temperatures, according to Wien *et al*. (1993).

Gandhi and Bains (2006) observed that mulches modified the microclimate by modifying soil temperature, soil moisture and evaporation and the customized microclimate affected the yield contributing characters. Crop under straw mulch created higher fruit weight and total yield as compared to no mulch. Wicks *et al*. (1994) and Khurshid *et al*. (2006) pointed out that maize grew taller under greater mulch levels, because of the availability of more soil moisture contents for plant growth. Shashidhar *et al*. (2009) reported that the total leaf yield of mulberry was originated highest in paddy straw mulched plots as compared to control plots. Khurshid *et al*., (2006) that mulching with crop residue not only affected both physical and chemical properties of the soil but also maintained good yield. The difference in development and yield attributes observed between the mulched and un-mulched plots may be attributed to the higher soil moisture reserves in the mulched plots since higher soil moisture is known to enhance efficient use of fertilizer while the excellent solar radiation during the growth seasons encouraged higher photosynthetic rates which culminated in the higher yields obtained.

Economic value

Recorded data in Tables (10, 11 and 12) present the economic evaluation of application organic mulches and those effects in productivity, some quality properties of fruit and net return income. Data in Tables (10 and 11) showed that applied organic mulch treatments increased fruit characteristics (number of fruit/plant and average fruit weight/plant), total yield and fruit quality compared with bare soil.

The greatest values of these parameters were found with wheat straw treatment follow in disorder by wood dust, maize straw, rice straw, and sugarcane straw treatments. The number of fruit per plant increased by (121.1, 115.8%), (78.9, 73.7%), (63.2, 57.9%), (42.1, 38.8%) and (21.1, 21.1%) with (wheat straw, wood dust, maize straw, rice straw and sugarcane straw treatments), respectively, in 2016 and 2017 seasons. When, these treatments (wheat straw, wood dust, maize straw, rice straw, and sugarcane straw) increased average fruit weight/plant value as follow (135.1, 136.9%), (91.1, 91.3%), (55.0, 55.0%), (26.4, 26.4%) and (12.8, 12.8%), respectively, in both tested seasons.

Whereas, highest values of total yield were obtained with applied organic mulches (wheat straw, wood dust, maize straw, rice straw, and sugarcane straw treatments) by (419.6, 419.7%), (242.0, 242.0%), (150.1, 150.2%), (77.3, 77.3%) and (36.6, 36.6%), respectively, in both growing seasons compared with bare soil.

In the same trained, content of fruit from total soluble sullied (T.S.S.) was increased by (33.0, 35.5%), (24.7, 25.8%), (16.5, 18.3%), (13.4, 17.2%) and (10.3, 11.8%), with (wheat straw, wood dust, maize straw, rice straw and sugarcane straw treatments), respectively, in season 2016 and season 2017. While, Fruit firmness obtained the maximum value as (103.6, 110.9%), (77.7, 77.6%), (54.6, 59.8%), (37.6, 45.3%) and (20.6, 25.9%) with treatments of organic mulch (wheat straw, wood dust, maize straw, rice straw and sugarcane straw), in two growing seasons, respectively. Moreover, fruits content from ascorbic acid was increased by applied organic mulches (wheat straw, wood dust, maize straw, rice straw, and sugarcane straw), by (8.6, 9.3%), (4.7, 5.7%), (3.1, 3.6%), (3.0, 3.7%) and (1.4, 0.70%), in both growing seasons, respectively.

On the other hand, determination of the significant differences between the different coefficients used in cultivating the crop in the one production season, ANOVA was separately conducted between the different coefficients of the two production seasons; the computed F value in the first season is about 13.817 while it estimates almost 7.42 in the second season. Its comparison to the controversial f estimated almost 4.22

Table 10. Economic evaluation of using different types of organic mulch on yield and its components of cantaloupe plants during 2016 and 2017 seasons.

Treatments	Number of fruit/plant	Average fruit weight (g)	Total yield/plant (Kg)
		First season	
Wheat straw	121.1%[a]	135.1% [a]	419.6%[a]
Wood dust	78.9%[b]	91.1% [b]	242.0%[b]
Maize straw	63.2%[c]	55.0% [c]	150.1%[c]
Rice straw	42.1%[d]	26.4% [d]	77.3%[d]
Sugarcane straw	21.1%[e]	12.8% [e]	36.6%[e]
		Second season	
Wheat straw	115.8%[a]	136.9%[a]	419.7%[a]
Wood dust	73.7%[b]	91.3%[b]	242.0%[b]
Maize straw	57.9%[c]	55.0%[c]	150.2%[c]
Rice straw	36.8%[d]	26.4%[d]	77.3%[d]
Sugarcane straw	21.1%[e]	12.8%[e]	36.6%[e]

Table 11. Economic evaluation of using different types of organic mulch on T.S.S, fruit firmness and ascorbic acid content of cantaloupe plants during 2016 and 2017 seasons.

Treatments	T.S.S	Fruit firmness	Ascorbic acid
		First season	
Wheat straw	33.0%[a]	103.6%[a]	8.6%[a]
Wood dust	24.7%[b]	77.7%[b]	4.7%[b]
Maize straw	16.5%[c]	54.6%[c]	3.1%[c]
Rice straw	13.4%[d]	37.6%[d]	3.0%[d]
Sugarcane straw	10.3%[e]	20.6%[e]	1.4%[e]
		Second season	
Wheat straw	35.5%[a]	110.9%[a]	9.3%[a]
Wood dust	25.8%[b]	77.6%[b]	5.7%[b]
Maize straw	18.3%[c]	59.8%[c]	3.6%[c]
Rice straw	17.2%[d]	45.3%[d]	3.7%[d]
Sugarcane straw	11.8%[e]	25.9%[e]	0.70%[e]

Table 12. Economic evaluation of using different types of organic mulch on net return (E. L.) and Return/E. L. investment of cantaloupe plants during 2016 and 2017 seasons.

Treatments	Production total cost E. L.	Total productivity par ton	Price of ton E. L.	Total income E. L.	Net return E. L.	Return/E. L. investment
			First season			
Wheat straw	900	6.155	950	5847.25	4947.25	6.496
Wood dust	900	4.051	950	3848.45	2948.45	4.276
Maize straw	900	2.964	950	2815.80	1915.80	3.128
Rice straw	900	2.100	950	1995.00	1095.00	2.216
Sugarcane straw	900	1.618	950	1537.10	637.10	1.707
Bare soil	900	1.184	950	1124.80	224.80	1.249
			Second season			
Wheat straw	900	6.023	950	5721.85	4821.85	6.358
Wood dust	900	3.964	950	3765.80	2865.8	4.184
Maize straw	900	2.899	950	2754.05	1854.05	3.060
Rice straw	900	2.054	950	1951.30	1051.30	2.168
Sugarcane straw	900	1.583	950	1303.85	603.85	1.448
Bare soil	900	1.159	950	1101.05	201.05	1.223

Source: calculated and collected from the sample data - the Ministry of Agriculture and land reclamation - Annual Bulletin of Agricultural Statistics, 2016.

indicates the computed value is higher than the controversial value in the two production seasons, this means there is significant differences at the level 0.01 in the one production season. This means acceptance of the alternative hypothesis and rejecting the null hypothesis that claims there were no significant differences between the different coefficients. To determine whether there were significant differences between different coefficients on the fruit and its production standards in the two production seasons; ANOVA was also conducted between the two production seasons. It indicates low computed f value compared to the controversial value and hence accepting the null hypothesis that claims there is no impact of the different coefficients in the two production seasons on the crop qualitative and quantitative standards while rejecting the alternative hypothesis.

Moreover, from Table (12) indicated that the total cost to produce cantaloupe plants under greenhouse (9 × 60 × 3.5 m), arrange 900 L. E. when variable cost ratio arranged 76.33% and fixed cost ratio arranged 23.64%. Also, the total production cost had not affect by applying the agricultural wastes as organic mulch, cause the wastes are considered as the most drivers of environmental pollution. Therefore, re-using these wastes as a mulch to produce cantaloupe plants is favorable contribute to the transformation of the negative impact of these wastes on the environment to positive impact. For that, agricultural wastes did not considered in different cost items.

In addition, greenhouse productivity was increased by using organic mulch treatments (wheat straw, wood dust, maize straw, rice straw and sugarcane straw) as follow (419.85, 419.67%), (280.41, 280.48%), (193.10, 193.23%), (107.66, 107.76%) and (51.94, 51.94%), respectively, in both tested seasons compared with bare soil. Furthermore, applying (wheat straw, wood dust, maize straw, rice straw and sugarcane straw) as organic mulch increased the net return for greenhouse by (5.496, 5.358), (5.247, 5.135), (4.789, 4.910), (4.280, 4.190), (3.368, 3.298) and (2.220, 2.174) EL., respectively, in two growing seasons. Generally, wheat straw treatment observed the greatest values of greenhouse productivity and net return/greenhouse compared with other treatments through the two growing seasons.

CONCLUSION

This investigation indicated that organic mulch improves physical and chemical properties of soil and substantially enhance the growth and yield of cantaloupe crop. Organic mulches can moderate fluctuations of soil temperature, conservation of soil moisture and enhancing organic matter content. Application of wheat straw treatment as mulch was the most effective treatment in increasing the all tested parameters in these investigations. The type of organic mulch to use may be dependent on factors such as cost, availability and production scale.

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