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Effect of Sheep Manure Application Rate and Method on Growth, Fruiting and Fruit Quality of Balady Guava Trees Grown Under Mid-Sinai Conditions

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Abstract: *This study was conducted during two consecutive seasons of 2013 and 2014 at El Maghara Station of Desert Research Center, North Sinai Governorate Egypt. The effects of sheep manure application rate i.e. 13, 26 and 39 kg/tree and application method namely surface, trench and circle on growth, fruiting and fruit quality of Balady guava trees were studied. Resulted showed that increasing sheep manure application rate induced a progressive enhancement of the studied growth, leaf mineral content, fruiting and fruit quality traits. Moreover, sheep manure circle application method surpassed the other two tested application methods in enhancing the previously mentioned studied traits. Consequently, it is preferable to apply sheep manure at 39kg/tree in circles to enhance growth, fruiting and fruit quality of Balady guava manure trees.*

Key words: *Balady guava; application rate; application method; sheep manure; growth; fruit quality.*

I. Introduction

The guava (*Psidium guajava*, L.) is one of the cheapest, popular and good source of vitamin C. Moreover, it is one of the leading fruit species in newly reclaimed soil in Egypt because of its high adaptability to thrive in these soils. Guava is adapted to varied soils, climatic conditions and salt stress (Muhammad et al., 2000). Many factors were suspected to cause the low yield and poor quality of fruits. These factors may include soil problems and poor management practices such as lack of fertilizers application. Fertilization is one of the most important practices needed to fruit trees growth. Use of chemical fertilizers in fruit crops has certainly increased of their crops productivity. Moreover, the indiscriminate and excessive use of mineral fertilizers in intensive agricultural or horticultural system play a role in the health problems and environmental pollution. Beside, the high cost of mineral fertilization is a big problem facing fruit tree grower (Kabeel et al., 2005). Organic manure can serve as alternative practice to mineral fertilizers (Gupta et al., 1988; Wong et al., 1999 and Naeem et al., 2006) for improves soil structure (Bin, 1983 and Dauda et al., 2008) and microbial biomass (Suresh et al., 2004), enhances physical and chemical properties of soil and increases soil nutrient and water-holding ability and crop production (Martens and Frankenberger, 1992; Turner et al., 1994; Dong et al., 1997; Zebarth et al., 1999; Moskal et al., 2001; Whalen et al., 2002 and Yamada, 2002). Organic manure increased soil organic matter and soil cation exchange capacity and soil available N and improved plant N status (Shufu and Huairui 2004). Furthermore, the low input of organic matter to soil and the intensive management of the orchards result in the reduction of organic matter content and quality of the soil (Canali et al., 2002). Organic matter is not only necessary for plant nutrition as slow release fertilizers but also essential for efficient plant production system (Benton, 1985). In addition, organic agriculture is a new system to avoid the use of chemical and synthetic fertilizers. Environmental influences on human health courage growers to convert to organic production (Fayed, 2005). Replacing chemical fertilizers by application of organic manure reduced the factors responsible for environmental pollution and also minimizes organic waste (Ram et al., 2007). Organic manure application improves leaf chlorophyll content and leaf N, P, K, Fe, Zn and Mn content of olive trees (Abdel-Nasser and Harash, 2001 and Abou El-Khashab et al., 2005). Also, it enhances vegetative growth parameters of guava cv. Sardar tree (Ram et al., 2007). In addition, organic fertilizer such as sheep manure contains both organic and inorganic forms of the plant nutrients. Moreover, sheep manure application improves soil properties through improving physiochemical and biological condition of the soil, its increased soil organic matter and soil cation exchange capacity, and therefore the soil nutrient retention capacity was increased. Moreover, sheep manure application increases soil available N and improves plant N status (Shufu and Huairui, 2004). Furthermore, sheep manure is recommended for olive cultivation under arid and semi-arid regions that are limited in water resources, especially sandy soil (Abdel-Nasser and Harash, 2001). On the other hand, Salama (2002) indicated that sheep manure soil application gave an high positive effect on leaf total chlorophyll content, fruit set, yield, fruit quality and leaf mineral content as compared with poultry manure soil application and sheep manure application surpassed cattle manure soil application in this concern Balady mandarin trees. On the other hand, organic manure in trench application exerted positive effect on leaf total chlorophyll content, fruit set, yield, fruit quality and leaf mineral content more than surface application of organic manure of

Washington navel orange tree (Moustafa, 2002) and confirmed by Salama (2002) on mandarin trees. Furthermore, sheep manure application improved growth of olive trees (Abdel-Nasser and Harash, 2001). Also, it enhanced fruit set, yield, leaf K, Fe, Mg and chlorophyll contents of olive trees (Fayed, 2010). Furthermore, agricultural waste plus 10% sheep manure application improved, flowering, fruit set, yield, fruit physical quality, and leaf mineral and chlorophyll content of Picual olive trees (AL-Kahtani and. Ahmed, 2012). However, agricultural waste plus 40% sheep manure application gave the highest initial fruit set and retained fruit, yield fruit quality and leaf N, P, K and Mn content of Barhy date palm (Al-Kahtani and Soliman 2012). Moreover, sheep manure application improves leaf chlorophyll content of apricot leaves (Duhoky et al., 2014). In addition, sheep manure increases leaf area, and leaf total chlorophyll content of apricot trees (Mosleh et al., 2014). However, this study was performed to study the effect of sheep manure rates (13, 26 and 39 kg/tree) and sheep manure application methods (surface, trench and circle applications) on tree growth, leaf mineral content, fruiting and fruit quality of Balady guava trees.

II. Material And Methods

Following a preliminary experiment carried out during 2012, this study was carried out during two successive seasons 2013 and 2014 at Experimental Orchard of El Maghara Station of Desert Research Center, North Sinai Governorate (latitude 30.35 N, longitude 33.20 E) in Egypt. Sixteen-year-old Balady guava trees (*Psidium guajava*, L) arised from seeds, nearly similar in growth vigor, healthy, planted at 7x7 m a part in sandy soil and irrigated through drip irrigation system from a well and received regularly the recommended horticultural practices were devoted for this study. Physical and chemical analysis of the experimental soil is shown in Table, 1 meanwhile the chemical analysis of used irrigation water is recorded in Table, 2. The selected guava trees were subjected to three rates of sheep manure fertilizer and three application methods of sheep manure in factorial experiment as follows:

Factor A, consisted of three rates of sheep manure i.e. 13 kg/tree (240.5 g/actual nitrogen /tree), 26 kg/tree (481 g/actual nitrogen /tree) and 39 kg/tree (721.5 g/actual nitrogen /tree). Factor B, consisted of three application methods of sheep manure namely soil surface, trench and circle application.

Surface application: Well decomposed organic sheep manure was applied superficial and digged in soil during deep hand hoeing practice (about 20 cm depth) in mid- January of each season. Trench application: in mid-January of both seasons two trenches (80 cm length x 40 cm width x 30 cm depth) were digged on both sides of the tree 1 m apart from the tree trunk in the direction of irrigation furrows. Circle application: in mid-January of both seasons circle trench (40 cm width x 30 cm depth) was digged around at the end of tree shade at 1 m apart from the tree trunk. Chemical analysis of sheep manure table, 3.

Table 1. Analysis of experimental soil of El-Maghara Station, North Sinai Governorate, Egypt

Soil Depth (cm)	Texture class	Organic matter (%)	PH Soil past	E.C. (dSm^{-1})	Soluble cations (mequiv./l)				soluble anions (mequiv./l)			
					Ca^{2+}	K^{+}	Na^{+}	Mg^{2+}	Cl^{-}	SO_4^{2-}	HCO_3^{-}	CO_3^{2-}
0-30	sand	0.22	7.40	0.90	4.00	0.15	3.30	1.50	5.20	1.95	1.80	-
30-60	sand	0.23	7.50	1.10	4.50	0.30	4.80	2.00	5.50	1.63	1.20	-

Table 2. Chemical analysis of water used for irrigation at El-Maghara Station, North Sinai Governorate, Egypt

PH	E.C. (dSm^{-1})	Soluble cations (mequiv./l)				soluble anions (mequiv./l)			
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
8.36	4.38	11.40	3.48	24.60	0.69	0	4.40	3.57	32.20

Table 3. Chemical analysis of sheep manure

N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe ppm	Mn ppm	Zn ppm	Organic matter content (%)
1.85	0.65	0.72	0.40	0.44	975	164	17	54.14

The tested treatments were arranged in a randomized complete block design with three replicates for each treatment and each replicate was represented by two trees. Moreover, the effect of sheep manure application rate and method on tree growth, leaf mineral content, tree fruiting and fruit quality was evaluated through the following determinations.

2.1. Tree growth

2.1.1. Shoot length and number of lateral shoots / branch:

On April, 1st and April, 3th of 2013 and 2014 seasons, respectively, four branches nearly uniform in diameter (about 5 cm) and length well distributed on different tree directions were labeled. Number of developed shoots per each branch were counted and tagged to determine shoot length when growth ceased in mid-December of both seasons.

2.1.2. Leaf area and leaf total chlorophyll content

In mid-September of both seasons, samples of twenty leaves (the third leaf from the base of the previously tagged non fruiting shoots) were collected and leaf area was determined according to, Helail et al. (1990) as follows:

Leaf area (mm^2) = - 158.0 + (0.810) (leaf length x leaf width).

Furthermore, leaf total chlorophyll content was measured by Minolta chlorophyll meter SPAD-502.

2.2. Leaf-mineral Content

In mid-September of 2013 and 2014 seasons, leaf samples were taken from the third and fourth leaf of shoot base, washed, dried at 60°C and digested according to Chapman and Pratt, (1961). Nitrogen was determined by the micro-kjeldahl method Pregl, (1945). Phosphorus was calorimetrically determined using Spekol spectrophotometer wave length 882 UV according to Matt, (1968). Potassium was determined by flame-photometer according to Brown and Lilleland, (1946). Calcium and magnesium were determined by titration against versenate solution (Na-EDTA) method as described by Chapman and Pratt, (1961).

2.3. Tree fruiting parameters

At full bloom of both seasons, thirty shoots of one-year old were chosen randomly and labeled of each treated tree. Moreover, number of flowers per each shoot was counted and recorded. Furthermore, in late May number of set fruitlets on the previously tagged shoots was counted and recorded. Fruit set percentage was calculated as follows:

$$\text{Fruit set (\%)} = \frac{\text{No. of set fruitlets}}{\text{No. of flowers at full bloom}} \times 100$$

In addition, number of retained fruits on the previously tagged shoots during late May and June and those retained just before harvesting (early August) were counted and recorded. Thereafter pre-harvest drop (%) was calculated on the basis of initial number of set fruitlets. In addition, it late August of both seasons, guava fruits were harvested as soon as they attained maturity indices. Fruits per each treated tree weighed in (Kg) and recorded.

2.4. Fruit quality parameters

2.4.1. Fruit physical properties

Samples consists of 10 fruits were randomly selected from each treated tree, where fruit weight, volume, length and diameter were determined and recorded.

2.4.2. Fruit chemical properties:

Total soluble solids (T.S.S.) of fruit juice were determined using Carl Zeiss hand refractometer. Total sugars (%) were determined according to Smith et al., (1956). Ascorbic acid was determined in fruit juice as mg/100 ml juice according to Horwitz, (1970). Titratable acidity percentage in fruit juice was determined according to Vogel, (1968).

Statistical analysis

The obtained data of both seasons were subjected to analysis of variance according to Clarke and Kempson, (1997) and the means were differentiated using Duncan multiple range test at 5% level, Duncan, (1955).

III. Results And Discussion

3.1. Tree growth

3.1. 1. Shoot length (cm)

It obvious from Table, 4 that sheep manure fertilization at 39 kg/tree enhanced shoot length than 13 and 26 kg/tree respectively. Moreover, 39 kg sheep manure /tree proved superiority in both seasons of study.

Moreover, sheep manure applied in circles enhanced shoot growth than trench and surface applications.

Furthermore, the interaction between rates and application methods of sheep manure exerted that 39 kg sheep manure/tree applied in circle superficially proved to be the most effect combination in enhancing shoot length of Balady guava trees. On the contrary, 13 kg sheep manure /tree applied superficially gave the lowest values of shoot length increase during both seasons of study.

Table 4. Effect of sheep manure application rate and method and their interactions on shoot length of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Shoot length (cm)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	4.13 f	4.42 d	4.51c	**4.35C**	4.17 i	4.35f	4.65 e	**4.39C**
26 kg/tree	4.25 e	4.68 b	4.72 b	**4.55B**	4.26 h	4.69 d	4.82 c	**4.59B**
39 kg/tree	4.27e	4.73 b	4.95 a	**4.65A**	4.29 g	4.88b	5.05 a	**4.74A**
	4.22C	**4.61B**	**4.72A**		**4.24C**	**4.64B**	**4.84A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.1.2. No. of lateral shoots/ branch

Table, 5 indicates that 39 kg sheep manure/tree produced higher number of lateral shoots/branch than 13 and 26 kg sheep manure/tree in both seasons of study.

Moreover, sheep manure circle application induced high positive effect on number of lateral shoots/branch followed by trench and surface application respectively in both seasons.

However, the interaction between rates and application methods of sheep manure shows that combinations of rates and application methods exerted high positive effect on number of lateral/shoot in both seasons. Generally, combinations of 39 kg sheep manure/tree sheep manure applied in circles showed superiority in this concern.

Table 5. Effect of sheep manure application rate and method and their interactions on number of lateral shoots/branch of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	No. of lateral shoots/branch							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	4.19 i	4.84 f	4.86 e	**4.63B**	4.83 i	5.09 f	5.25 e	**5.05 C**
26 kg/tree	4.68 h	4.95 d	5.08 c	**4.90A**	4.91 h	5.32 d	5.36 c	**5.20 B**
39 kg/tree	4.70 g	5.28 b	5.36 a	**5.10A**	4.94 g	5.41 b	5.44 a	**5.26** A
	4.52C	**5.03B**	**5.10A**		**4.90 C**	**5.27B**	**5.35 A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.1.3. Leaf surface area (cm^2)

Table, 6 illustrates that 39 kg sheep manure/tree produced more expanded leaves and surpassed 13 kg sheep manure /tree and 26 kg sheep manure /tree in both seasons.

Moreover, sheep manure applied in circle produced larger leaves than trench and surface application in both seasons.

In addition, the interaction between sheep manure application rate and method shows that 39kg sheep manure/tree applied in circle exerted the highest simulative effect on leaf surface area followed by 39kg sheep manure /tree applied in trench application. Other combination gave an intermediate values in this concern.

Table 6. Effect of sheep manure application rate and method and their interactions on leaf surface area of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Leaf surface area (cm^2)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	37.34 i	40.39f	41.36d	**40.03C**	42.66h	43.69 f	48.63e	**44.99C**
26 kg/tree	39.33h	41.38e	42.38c	**41.00B**	43.67g	48.65d	49.61c	**47.31B**
39 kg/tree	39.36 g	44.37b	46.39a	**43.37A**	43.68fg	50.60b	52.64a	**48.97A**
	38.68C	**42.05B**	**43.71A**		**43.34C**	**47.65B**	**50.29A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.1.4. Leaf total chlorophyll content

Table, 7 shows that 39 kg sheep manure/tree produced the highest values of leaf total chlorophyll content followed by 26 kg/tree and 13 kg/tree respectively in both seasons.

Moreover, circle application exerted high positive effect on leaf total chlorophyll content and surpassed other tested applications methods in both seasons

On the other hand, interaction between rates and application methods shows that 39 kg/tree applied in circle application gave the highest values of leaf total chlorophyll content surpassed other combinations in both seasons. Other combination gave an intermediate values in this concern.

Table 7. Effect of sheep manure application rate and method and their interactions on leaf total chlorophyll content of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Total chlorophyll							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	61.66i	66.68f	68.67e	**65.67C**	63.39 i	68.32 f	68.34 e	**66.68C**
26 kg/tree	62.32h	69.63d	70.64c	**67.53B**	64.38 h	69.30 d	71.30 c	**68.36B**
39 kg/tree	64.65g	72.61b	75.60a	**70.92A**	68.01 g	72.39 b	77.30 a	**72.57A**
	62.88C	**69.61B**	**71.64A**		**65.26C**	**70.00B**	**72.34A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.2. Leaf mineral content

3.2.1. Nitrogen (%)

Table, 8 demonstrates that increasing in sheep manure rate led to increasing leaf nitrogen content of Balady gave tree in both season. Generally, 39 kg/tree sheep manure proved to be the superior rate in this concern scored (2.12 and 2.17 %) followed by 13 kg sheep manure/tree (2.04 and 2.07%) and 26 kg sheep manure/tree (2.07, 2.09 %) in 2013 and 2014 seasons, respectively.

In general, circle application method scored 2.19 and 2.23 % against 1.88 and 1.91 % for surface application in both seasons.

Furthermore, interaction between sheep manure application rate and method shows that 39 kg sheep manure/tree applied in circles enhanced leaf nitrogen content and scored (2.25 and 2.33 %) against (1.86 and 1.88 %) for 13 kg sheep manure/tree applied in surface application in both seasons. Other tested combinations gave an intermediate values in this concern.

Table 8. Effect of sheep manure application rate and method and their interactions on leaf nitrogen content of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	N (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	1.86g	2.12e	2.14d	**2.04C**	1.88h	2.15e	2.16de	**2.07C**
26 kg/tree	1.89f	2.14d	2.17c	**2.07B**	1.90g	2.17d	2.20c	**2.09B**
39 kg/tree	1.89f	2.20b	2.25a	**2.12A**	1.93f	2.24b	2.33a	**2.17A**
	1.88C	**2.16B**	**2.19A**		**1.91C**	**2.19B**	**2.23A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.2.2. Phosphorus (%)

Table, 9 demonstrates that 39 kg sheep manure/tree had higher values of leaf phosphorus content (0.14 and 0.15 %) against (0.12 and 0.13 %) for 13 kg sheep manure/tree sheep manure application respectively in both seasons.

However, circle application enhanced leaf phosphorus content than trench and surface applications in first season. While, circle and drench application gave similar and high values of leaf phosphorus content than surface application in the second season.

Furthermore, the interaction between rates of sheep manure and application methods show that 39 kg/tree applied in circle and trench applications gave the highest leaf phosphorus content in the first season. Generally, 39 kg sheep manure/tree applied in circle proved to be the superiority application in this concern.

Table 9. Effect of sheep manure application rate and method and their interactions on leaf phosphorus content of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	P (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	0.11d	0.12bcd	0.11bcd	**0.12B**	0.11d	0.13cd	0.14bc	**0.13B**
26 kg/tree	0.11bcd	0.12bcd	0.14b	**0.12B**	0.12d	0.14bc	0.15ab	**0.14AB**
39 kg/tree	0.12bcd	0.15a	0.16a	**0.14A**	0.12d	0.15ab	0.16a	**0.15A**
	0.11B	**0.13B**	**0.14A**		**0.12B**	**0.14A**	**0.15A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.2.3. Potassium (%)

Table, 10 illustrates that 39 kg sheep manure/tree enriched leaf potassium content and scored (1.29 and 1.31 %) against (1.25 and 1.28 %) for 13 kg sheep manure/tree in both seasons.

Moreover, circle application had the highest values of leaf potassium content as compared with surface application in the first season. While, circle and trench application methods gave similar and higher values of leaf potassium content in the second season.

Furthermore, the interaction between sheep manure application rate and method shows that in the first season 39 kg sheep manure/tree applied in circle and in the second season 39 kg sheep manure/tree applied in circle and trench exerted similar and higher values of leaf potassium content and proved to be the best combinations in this concern. Other combination gave an intermediate values in this respect.

Table 10. Effect of sheep manure application rate and method and their interactions on leaf potassium content of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	K(%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	1.23f	1.25e	1.27d	**1.25C**	1.26f	1.29de	1.30cd	**1.28C**
26 kg/tree	1.24ef	1.28cd	1.29bc	**1.27B**	1.26f	1.31bc	1.32ab	**1.30B**
39 kg/tree	1.25ef	1.30b	1.32a	**1.29A**	1.28ef	1.33a	1.33a	**1.31A**
	1.24C	**1.27B**	**1.29A**		**1.26B**	**1.31A**	**1.32A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.2.4. Calcium (%)

Table, 11 indicates that 26 and 39 kg sheep manure/tree enhanced leaf calcium content than 13 kg sheep manure/tree in the first season. While, sheep manure rates had no effect on significant leaf calcium content in the second season.

Moreover, circle and trench application method enhanced leaf calcium content than surface application in the first season. Whereas, sheep application method manure had no positive effect on leaf calcium content in the second season.

However, the interaction between sheep manure application rate and method shows that 26 kg sheep manure/tree applied in circle and 39 kg sheep manue/tree applied in trench and circle exerted similar and higher positive effect on leaf calcium content and proved to be the superiority applications in this concern. Furthermore, other combinations application rate and method showed no remarkable positive effect on leaf calcium content in the second season.

Table 11. Effect of sheep manure application rate and method and their interactions on leaf calcium content of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Ca (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	1.71c	1.73b	1.74ab	**1.72B**	1.71a	1.72a	1.73a	**1.72A**
26 kg/tree	1.72bc	1.74ab	1.75a	**1.74A**	1.72a	1.73a	1.73a	**1.73A**
39 kg/tree	1.73b	1.75a	1.75a	**1.74A**	1.72a	1.73a	1.73a	**1.73A**
	1.72B	**1.74A**	**1.74A**		**1.72A**	**1.73A**	**1.73A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.2.5. Magnesium (%)

Table, 12 shows that sheep manure rate had no significant effect on leaf magnesium content in both seasons.

Moreover, application method had no significant effect on leaf magnesium content in both seasons.

Furthermore, the interaction between sheep manure application rate and method exerted similar and higher positive effect on leaf magnesium content in the first season. Generally, 39 kg sheep manure/tree applied in circle proved to be the best interaction in this concern. Whereas, combinations between the two tested factors showed no positive effect on leaf magnesium content in the second season.

The improvement in tree growth and leaf mineral content due to sheep manure application may be explained by the fact that sheep manure induced positive effect on physical conditions of the soil; creates favourable conditions for root growth and nutrients absorption; it supplies much nutrients, and it facilitates the absorption of fixed nutrients by tree roots (Fayed, 2010; Abdel-Nasser and Harash, 2001 and Shufu and Huairui, 2004). Sheep manure enhanced leaf contents of chlorophyll a and b, such increases reflected on tree growth that resulted from the high water absorption and more uptakes of N, Mg and Fe as such elements have close association in chlorophyll a and b biosynthesis (Hegazi et al., 2007and Hall and Rao, 1996). Moreover, Li et al.

(1998) pointed out that organic manure increased the soil content of IAA and cytokinins and stimulated plant growth.

Table 12. Effect of sheep manure application rate and method and their interactions on leaf magnesium content of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Mg(%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	0.66b	0.67b	0.67ab	**0.68A**	0.68a	0.69a	0.69a	**0.68A**
26 kg/tree	0.66b	0.67ab	0.67ab	**0.67A**	0.68a	0.69a	0.69a	**0.68A**
39 kg/tree	0.66ab	0.67ab	0.68a	**0.68A**	0.69a	0.69a	0.69a	**0.69A**
	0.67A	**0.67A**	**0.68A**		**0.68A**	**0.69A**	**0.69A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

The results of sheep manure in enhancing tree growth and leaf mineral content are confirmed by the findings of El-Hady et al. (1991) who found that fertilizing olives with organic manure gave the higher leaf of chlorophyll a and b, N, P, K, Ca, Mg, Fe, Zn and Mn content. Increases in leaf nutrients content may be attributed to enhancing the availability of soil nutrients in the root zone that retained against leaching in deep layers resulting in more available nutrients to plant uptake Moreover, Abdel-Nasser and Harash (2001) stated that sheep manure increased olive leaf K, Mg and Fe contents. Moreover, Salama (2002) reported that sheep manure treatment enhanced tree growth, leaf surface area, total chlorophyll and leaf mineral content of Balady mandarin trees. Furthermore, Mosleh et al. (2014) indicated that sheep manure application increased leaf area, and leaf total chlorophyll content of apricot trees.

Furthermore, the enhancement of tree growth and leaf mineral content due to circle and trench application of sheep manure may be due to the fact that the incorporation of manure in the soil provided a protection against nutrients losses (Cook 1982).

On the other hand, sheep manure application methods in this respect go in line with the reports of Salama (2002) on Balady mandarin trees.

3.3 Tree fruiting

3.3. Fruit set (%)

Table, 13 indicates that 39 kg sheep manure/tree induced high percentage of set fruits than rates of 13 kg sheep manure/tree and 26 kg sheep manure/tree in both seasons.

Moreover, method applications in circle exerted the highest values of fruit set percentage than other two tested application methods in both seasons.

Moreover, the interaction between sheep manure application rate and method gave a pronounced effect on fruit set percentage in both seasons. Generally, 39 kg sheep manure/tree applied in circle surpassed other combinations. Other tested combinations gave an intermediate values in this concern.

Table 13. Effect of sheep manure application rate and method and their interactions on fruit set of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Fruit set (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	20.70h	24.77f	26.00e	**23.82C**	21.87i	26.77f	27.27e	**25.30C**
26 kg/tree	21.10h	27.60d	29.00c	**25.90B**	22.37f	27.67d	29.87c	**26.63B**
39 kg/tree	22.03g	31.30b	33.27a	**28.86A**	23.20g	31.00b	34.38a	**29.54A**
	21.28C	**27.89B**	**29.42A**		**22.50C**	**28.47B**	**30.50A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.4. Pre harvest (%)

Table, 14 illustrates that 39 kg sheep manure/tree reduced pre harvest fruit drop percentage and scored (8.07 and 8.60 %) followed by 13 kg sheep manure/tree sheep manure scored (9.04 and 9.32 %) and 26 kg sheep manure/tree scored (8.57 and 8.97 %) in both seasons.

Moreover, circle application reduced pre harvest percentage and scored (7.74 and 8.29 %) against (9.63 and 9.77 %) for surface application in both seasons.

Moreover, the interaction between sheep manure application rate and method reduced pre harvest percentage in both seasons. Generally, combination of 39 kg sheep manure/tree applied in circle scored (7.12 and 7.87 %) against (9.72 and 9.90 %) for 13 kg sheep manure/tree surface application in both seasons. Other combinations gave an intermediate values in this concern.

Table 14. Effect of sheep manure application rate and method and their interactions on pre-harvest percentage of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Pre-harvest (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	9.72a	8.96d	8.44e	**9.04A**	9.90a	9.29d	8.76f	**9.32A**
26 kg/tree	9.69b	8.37f	7.65g	**8.57B**	9.77b	8.88e	8.25h	**8.97B**
39 kg/tree	9.48c	7.62h	7.12i	**8.07C**	9.65c	8.30g	7.87i	**8.60C**
	9.63A	**8.32B**	**7.74C**		**9.77A**	**8.82B**	**8.29C**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.5. Yield kg/tree

Table, 15 indicates that 39 kg sheep manure/tree improved fruit yield of Balady guava trees and scored (66.18 and 68.11kg/tree) as compared with 13 kg sheep manure/tree scored (61.98 and 62.97kg sheep manure/tree) in both seasons.

However, circle application increased yield and scored (66.19 and 68.45 kg/tree) against (61.12 and 60.60 kg/tree) for surface application in both seasons.

As for the interaction between of sheep manure application rate and method 39 kg sheep manure/tree applied in circle surpassed other combinations and scored (69.04 and 72.37 kg/tree) against (59.73 and 59.00 kg /tree) for 13 kg sheep manure/tree surface application in both seasons. Other combinations gave an intermediate values in this concern.

Table 15. Effect of sheep manure application rate and method and their interactions on yield of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Yield (kg)/tree							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	59.73i	62.64f	63.57e	**61.98C**	59.00i	64.33f	65.60e	**62.97C**
26 kg/tree	61.41h	64.39d	65.61c	**63.80B**	60.35h	66.58 d	67.39 c	**64.77B**
39 kg/tree	62.22g	66.51b	69.04a	**66.18A**	62.46g	69.51b	72.37 a	**68.11A**
	61.12C	**64.51B**	**66.19A**		**60.60C**	**66.80B**	**68.45A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level

The enhancement of flowering and fruiting due to the fact that sheep manure application may be due to sheep manure can serve as alternative practice to mineral fertilizers (Gupta et al., 1988; Wong et al., 1999 and Naeem et al., 2006) improving soil structure (Bin, 1983; Dauda et al., 2008) and microbial biomass (Suresh et al., 2004). Moreover, the stimulation effect of the absorbed nutrients on photosynthesis process which certainly reflected positively on the flowering characteristics (Bhangoo et al., 1988). Also, the slow release of nutrients resulted from the biodegradation of manure by soil microorganisms could explain the present results (Cole et al., 1987). However, the capability of soil microorganisms produces growth regulators such as auxins, cytokinines and gibberellins which had a positive effect on flowering process and nutrients uptake (Martin et al., 1989). Furthermore, sheep manure increased soil organic matter and soil cation exchange capacity and soil available N and improved plant N status (Shufu and Huairui 2004) as well as it releases much more or less available elements particularly, P, Fe, Zn, and Mn (Benton, 1985) and it increases the soil content of IAA and cytokinins (Li et al, 1998). Furthermore, the stimulation effect of the absorbed nutrients on photosynthesis process which certainly reflected positively on tree flowering and fruiting (Bhangoo et al., 1988).

The results of flowering and fruiting induced by sheep manure are emphasized by the findings of Salama (2002) on Balady mandarin trees who realized the highest flowering parameters and tree yield were produced by sheep manure application.

The obtained results regarding the effect of sheep manure application method on flowering and tree yield go in line with those mentioned by Fisum and Kodzokov (1991) on plum, Goede (1993) on mango, Moustafa (2002) on Washington navel orange trees and Salama (2002) on Balady mandarin trees.

3.6. Fruit quality

3.6.1. Fruit weight (g)

Table, 16 demonstrates that increasing in sheep manure rate increased fruit weight in both season. Generally, 39 kg sheep manure/tree proved to be the superior rate and scored (102.5 and 1.06.6 g) followed by 13 kg sheep manure/tree sheep manure fertilization (99.6 and 102.8 g) and 26 kg sheep manure/tree (100.5 and 1.05.3 g) for in both seasons.

However, circle application scored (107.3 and 111.9 g) against (89.3 and 93.0 g) for surface application in both seasons.

Furthermore, interaction between sheep manure application rate and method shows that 39 kg sheep manure/tree applied in circle increased fruit weight and scored (110.3 and 114.0 g) against (88.3 and 92.3 g) for 13 kg sheep manure/tree applied in surface in both seasons. Other combination gave an intermediate values in this concern.

Table 16. Effect of sheep manure application rate and method and their interactions on fruit weight of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Fruit weight (g)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	88.3i	105.0f	105.36e	**99.6C**	92.3h	106.7e	109.4d	**102.8C**
26 kg/tree	89.3h	105.7d	106.33c	**100.5B**	93.3g	110.3c	112.3b	**105.3B**
39 kg/tree	90.4g	106.7b	110.31a	**102.5A**	93.4f	112.3b	114.0a	**106.6A**
	89.3C	**105.8B**	**107.3A**		**93.0C**	**109.8B**	**111.9A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.6.2. Fruit volume (cm^3)

Table, 17 demonstrates that 39 kg sheep manure/tree improved fruit volume and surpassed other two tested rates both seasons. Whereas, 13 and 26 kg sheep manure/tree fertilization respectively gave similar significant values in the first season.

Moreover, circle application improved fruit volume and surpassed other trench and surface applications in both seasons

Furthermore, interaction between sheep application rate and method exerted high values of fruit volume in both seasons. Generally, combination of 39 kg sheep manure/tree applied in circle surpassed other tested combinations in this respect. On the contrary, 13 kg sheep manure/tree applied superficially gave the lowest values in this concern.

Table 17. Effect of sheep manure application rate and method and their interactions on fruit volume of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Fruit volume (cm^3)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	86.3i	103.4e	103.3f	**97.7B**	89.8g	102.8e	106.7d	**99.7C**
26 kg/tree	86.7h	103.7c	103.8b	**98.1B**	91.8f	106.8c	108.7b	**102.4B**
39 kg/tree	87.4g	104.0b	108.7a	**104.0A**	91.8f	108.7b	109.8a	**103.4A**
	86.8C	**103.7B**	**105.3A**		**91.1C**	**106.1B**	**108.4A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.6.3. Fruit length (cm)

Table, 18 indicates that 39 kg sheep manure/tree produced longer fruit than 13 and 26 kg sheep manure/tree in both seasons.

However, circle application gave higher value of fruit length than trench and surface application methods in both seasons. Whereas, circle and trench applications gave similar significant values than surface application in the second season.

As for, interaction between sheep manure application rate and method generally, in the first season 39 kg sheep manure/tree applied in circles and combination of 39 kg sheep manure/tree applied in circle and trench application in the second season exerted similar significant values of fruit length and surpassed other tested combinations in this respect.

3.6.4. Fruit diameter (cm)

Table, 19 shows that 39 kg sheep manure/tree gave wider fruits than 13 and 26 kg sheep manure/tree in both seasons. Whereas, 13 kg sheep manure/tree showed the lowest values of fruit diameter values.

However, circle application gave a high positive effect on fruit diameter than both trench and surface applications in both seasons.

Moreover, in the first season combination of 39 kg sheep manure/tree applied in trench and circle and in the second season combinations of 26 and 39 kg sheep manure/tree applied in circle gave similar and high values and surpassed other tested combinations in this respect.

Table 18. Effect of sheep manure rates, application methods and their interactions on fruit length of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Fruit length (cm)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	5.20 g	5.38 e	5.44 d	**5.34 C**	5.10 g	5.69 d	5.71 c	**5.50 C**
26 kg/tree	5.21 g	5.53 c	5.52 c	**5.42 B**	5.22 f	5.79 b	5.78 b	**5.60 B**
39 kg/tree	5.29 f	5.59 b	5.63 a	**5.50 A**	5.39 e	6.19a	6.20 a	**5.93 A**
	5.23C	**5.50B**	**5.53 A**		**5.24 B**	**5.89 A**	**5.90 A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

Table 19. Effect of sheep manure application rate and method and their interactions on fruit diameter of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Fruit diameter (cm)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	4.63 g	5.25 d	5.53 c	**5.13 C**	4.72 h	5.29 e	5.59 d	**5.20 C**
26 kg/tree	4.82 f	5.71ab	5.70 b	**5.41 B**	4.90g	5.75 c	5.83 a	**5.49 B**
39 kg/tree	4.94 e	5.72 a	5.72 a	**5.46 A**	5.01 f	5.80 b	5.84 a	**5.55 A**
	4.80 C	**4.56 B**	**4.65 A**		**4.88 C**	**5.61 B**	**5.75 A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.6.5. T.S.S. (%)

Table, 20 demonstrates that in the first season 26and 39 kg sheep manure/tree fertilized trees had similar and higher values of TSS as compared with 13 kg/tree sheep manure rate. In the second season 39 kg sheep manure/tree application gave the highest value of TSS as compared with 13 kg sheep manure/tree and 26 kg sheep manure/tree.

Furthermore, circle application increased TSS and scored (11.62 and 11.05%) against (9.91 and 9.79 %) for surface application and trench application method scored (11.61 and 10.82 %) in between values in both seasons.

Moreover, in the first season combination of 39 kg sheep manure/tree applied in circle surpassed other tested combinations and scored (11.95 %) against (9.77 %) for 13 kg sheep manure/tree applied in superficially. However, in the second season combinations of 39 kg sheep manure/tree applied in trench and circle gave similar and high values of TSS and surpassed other combinations.

Table 20. Effect of sheep manure application rate and method and their interactions on T.S.S. of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	T.S.S. (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	9.77 f	10.95 d	10.99 c	**10.57B**	9.75 g	9.95e	10.28 d	**9.93 C**
26 kg/tree	9.98 e	11.94 ab	11.93 b	**11.28A**	9.86 f	10.60 c	10.95 b	**10.47B**
39 kg/tree	9.99 e	11.93 b	11.95 a	**11.29A**	9.94 e	11.92 a	11.93a	**11.26A**
	9.91 C	**11.61B**	**11.62A**		**9.79 C**	**10.82B**	**11.05A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.6.6. Total sugar (%)

Table, 21 illustrates that 39 kg sheep manure/tree increased fruit total sugar content and surpassed 13 and 26 kg sheep manure/tree fertilization in both seasons. Generally 39 kg sheep manure/tree proved to be the superior rate n this concern.

However, circle application method increased fruit total sugar content and scored (11.49 and 10.04 %) against (9.94 and 8.49 %) for surface application in both seasons. Trench application method scored in between values in this respect.

Moreover, in the first season combination of 39 kg sheep manure/tree applied in circle and in the second season combinations of 39 kg sheep manure/tree applied in trench and circle increased fruit total sugar content surpassed other tested combinations in this concern.

Table 21. Effect of sheep manure application rate and method and their interactions on fruit total sugar content of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Total sugar (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	8.27 h	10.35 e	11.34 d	**9.99 C**	8.16 f	9.24 d	9.36 c	**8.92 C**
26 kg/tree	8.78 g	11.43 c	11.56 b	**10.59B**	8.17 f	9.89 b	9.88 b	**9.31 B**
39 kg/tree	9.76 f	11.56 b	11.58 a	**10.97A**	9.15 e	10.85 a	10.86 a	**10.29A**
	9.94 C	**11.11B**	**11.49A**		**8.49 C**	**9.99 B**	**10.04A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.6.7. Ascorbic acid (mg/100 ml juice)

Table, 22 shows that 39 kg sheep manure/tree fertilization induced high positive effect on fruit ascorbic acid content and surpassed 13 and 26 kg/tree sheep manure fertilization respectively in both seasons. Whereas, 13 kg sheep manure/tree fertilization gave the lowest values of fruit ascorbic acid content in both season.

However, circle application method gave a high positive effect on fruit ascorbic acid content than both trench and surface application in both seasons.

Moreover, in the first season combinations of 26 kg sheep manure/tree applied in circle and 39 kg sheep manure/tree applied in trenches and circles and in the first second season combination of 39 kg sheep manure/tree applied in circles increased fruit ascorbic acid content and surpassed other tested combinations.

Table 22. Effect of sheep manure application rate and method and their interactions on ascorbic acid of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Ascorbic acid (mg /100 ml juice)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	69.67g	79.00d	80.35c	**76.34C**	70.33g	76.35e	79.30d	**75.33C**
26 kg/tree	72.64f	88.30b	89.32a	**83.42B**	72.31f	83.34c	86.39b	**80.68B**
39 kg/tree	73.65e	89.32a	89.33a	**84.10A**	72.32f	86.38b	88.40a	**81.70A**
	71.99C	**85.54B**	**86.33A**		**71.65C**	**82.02B**	**84.03A**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

3.6.8. Acidity (%)

Table, 23 illustrates that 39 kg sheep manure/tree reduced acidity percentage than 13 and 26 kg sheep manure/tree fertilization in both seasons. Generally 39 kg sheep manure /tree scored (0.62 and 0.62 %) against (0.70 and 0.69 %) for 13 kg sheep manure/tree application in both seasons.

However, in the first season circle application reduced fruit acidity percentage and in the second season trench and circle application gave similar values and reduced acidity percentage as compared with surface application.

Moreover, in the first season combination of 39 kg sheep manure/tree applied in circles and combinations of 39 kg sheep manure/tree applied in trench and circle in the second season reduced acidity percentage and surpassed other combinations.

Table 23. Effect of sheep manure application rate and method and their interactions on acidity of Balady guava trees (2013 and 2014 seasons).

sheep manure rate	Acidity (%)							
	Application method							
	2013				2014			
	Surface	Trench	Circle	**Mean**	Surface	Trench	Circle	**Mean**
13 kg/tree	0.74a	0.69c	0.67d	**0.70A**	0.72a	0.68 c	0.68c	**0.69A**
26 kg/tree	0.71b	0.66d	0.62e	**0.66B**	0.70b	0.67cd	0.66d	**0.68B**
39 kg/tree	0.69c	0.60f	0.58g	**0.62C**	0.68c	0.59e	0.58e	**0.62C**
	0.71A	**0.65B**	**0.62C**		**0.70A**	**0.65B**	**0.64B**	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

The improvement in fruit quality, resulted due to sheep manure application, may be attributed to the fact that slow release nutrients resulted from the biodegradation of manure by soil microorganisms could explain

the present results (Cole et al., 1987). Moreover, it may be due to the improvement of physical and chemical properties of soil and increase soil nutrient and water-holding ability (Martens and Frankenberger 1992, Turner et al 1994, Dong et al., 1997, Zebarth et al 1999, Moskal et al 2001, Whalen et al 2002, Yamada 2002).Also, the stimulation effect of sheep manure on absorbed nutrients reflected on photosynthesis process then produced more carbohydrates which certainly reflected positively on the fruit quality (Hegazi et al., 2007). On the other hand, the capability of soil microorganisms to produce growth regulators such as auxins, cytokinines and gibberellins which had a positive effect on fruit quality and nutrients uptake (Martin et al., 1989).

The results of fruit quality induced by sheep manure were emphasized by the findings of Salama (2002) on Balady mandarin trees who realized the highest flowering and fruiting of mandarin trees were enhanced due to sheep manure application.

The obtained results regarding the effect of sheep manure application method on fruit quality go in line with those mentioned by Fisum and Kodzokov (1991) on plum, Goede (1993) on mango, Moustafa (2002) on Washington navel orange trees and Salama (2002) on Balady mandarin trees.

IV. Conclusion

Conclusively, sheep manure at 39 kg/tree applied in circles induced the highest positive effect on the studied tree growth, fruiting and fruit quality traits as well as leaf mineral content of Balady guava trees.

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