Improving Mineral Status, Productivity and Fruit Quality of Guava Trees (*Presidium guajava* L.) Using some Organic Manure Extracts as a Foliar Application

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Abstract: In order to study the response of productivity and fruit quality of guava trees to three foliar applications of three organic manures extracts namely: Farmyard, plant compost and chicken manure. A field trial was carried out during two seasons (2019 and 2020) on ten years old guava trees grown in sandy calcareous soil located at Cairo-Alexandria desert road (70 km from Cairo city, Egypt). The trees received three sprays from these organic manures extracts at start of vegetative growth (first of March), just fruit setting (first of April) and one month later. The obtained data showed that, spraying the three organic manures extracts, individually or in combination, significantly enhanced leaves mineral contents (N, P, K and Mg) rather than untreated trees. Whereas, only the three organic manure extract mixtures (chicken manure (Ch.ME) + compost manure (CME) + farmyard (FME)) significantly increased Ca % in leaves, during the second season. Remarkable and significant increase was observed for yield (kg/tree) and its components (fruit number/tree and average fruit weight) as a result of spraying the three organic manure extracts individually or in combination compared to untreated trees. Spraying the three organic manure extracts (Ch.ME, CME and FME) significantly improved all physical properties of fruit in terms fruit height (cm), fruit diameter (cm), and pulp thickness (cm), as well as fruit chemical properties in terms of TSS %, total sugars % and vitamin C (mg/100 g F.W.) and decreased total acidity %. The best results with regard to yield/tree, fruit physical and chemical properties of guava trees were obtained when the trees were treated three times with the mixture of the three organic manure extracts in combinations (Ch.ME + CME + FME).

Keywords: *Psidium guajava,* calcareous soil, chicken manure, compost manure, farmyard manure

INTRODUCTION

Guava (*Psidium guajava* L.) considered one of the most important fruit crops throughout the tropical and subtropical zones. In Egypt, guava is a popular fruit, because of low price and rich source of vitamins and minerals. Under new reclamation desert, guava is one of the leading fruit trees due to its high adaptability and thrives in these soils (Ibrahim *et al.,* 2010). Increasing the percentage of lime in the soil leads to increase soil pH and fixe many nutrient elements, which negatively affects the trees productivity and fruit quality.

Organic manures fertilizers have an announced role in improving yield and fruit quality of fruits. This is attributed to the increase on the release of most nutrients due to this change from solid to liquid form. Using organic manures achieves many important functions when applied to the fruit crops at the optimum time and concentration. This is attributed to its high content of all nutrients, as well as the higher availability of these nutrients (Marschner, 1995; Mahfouz, 2011; Ahmed *et al.,* 2014; Ibrahim *et al.,* 2015).

The present investigation aimed to study the effect of three organic manure extracts namely; chicken (Ch.M), plant compost (CM) and farmyard (FMT) manure extracts as a foliar application on nutritional status, yield (kg/tree) and its components, as well as fruit physical and chemical properties of Balady guava trees grown in new reclamation sandy calcareous soil.

MATERIALS AND METHODS

This investigation was carried out during 2019 and 2020 seasons on twenty four uniform 10 years old guava trees. The selected trees were grown in a private orchard located at Cairo-Alexandria desert road (70 km from Cairo city, Egypt), where the soil texture was sandy loam (Table 1). The planting space was 5 × 5 m and drip irrigation system was followed. The selected trees were pruned in the middle of January during the two experimental seasons. The experiment included eight treatments of the three organic manures extracts and its combination, as followed: (1) control treatment, trees sprayed with water; (2)spraying chicken manure (Ch.ME) at 10%; (3) spraying compost manure (CME) at 10%; (4) spraying farmyard (FM) at 10%; (5) spraying Ch.ME at 10% + CME at 10%; (6) spraying Ch.ME at 10% + FME at 10%; (7) spraying CME at 10% + FME at 10%; (8) spraying the mixture of Ch.ME + CME + FME. The three organic manures and their combinations were sprayed three times during each season on growth starting at (1st week of March), just after fruit setting (1st week of April) and one month later (1st week of May). Triton B as wetting agent at 0.05% was mixed with all organic manure solutions, as well as control solution, before application; spraying was carried out till runoff. The chosen trees under this study were subjected to regular horticulture practices that were commonly applied in the orchard including irrigation, fertilization and pest control.

Soil and water analysis:

Samples of soil and irrigation water were collected and subjected to physical and chemical analysis according to the procedures of Wilde *et al.* (1985), Walsh and Beaton (1986) the data are shown in Table (1).

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Table (1): Physical and chemical analysis of experiment orchard soil and irrigation water

Soil analysis		Water analysis	
Constituents	**Values**	**Constituents**	**Values**
Sand %	68,1	**E.C (ds. m^{-1})**	1.23
Silt %	23.4	**Hardness**	16.7
Clay %	8.5	**pH**	7.25
Texture	Sandy Loam	**Ca (mg/L)**	38.4
EC (1 : 2.5 extract) $d.m^{-1}$	2.1	**Mg (mg/L)**	24.3
Organic matter %	0.89	**K (mg/L)**	5.07
pH (1 : 2.5 extract)	8.18	**Na (mg/L)**	95.8
Active lime %	12% ($CaCO_3$)	**Sum of Cations (mg/L)**	8.16
N (mg/kg)	199	**Alkalinity (mg/L)**	182
Phosphorus (ppm)	10.80 ppm	**Chlorides (mg/L)**	121
Available Ca (meq/100g)	17.9	**Nitrate (mg/L)**	11.0
Available Mg (meq/100g)	3.33	**Sulphates (mg/L)**	53.1
Available K (meq/100g)	0.56	**Sum of anions (mg/L)**	7.69

Experimental design and data analysis:

The experiment of design a randomized complete block design (RCBD) and the statistical analyses were performed with SPSS program (SPSS Inc., Chicago, USA). Each treatment was replicated three times; means of the treatments were compared using New LSD test ($P<0.05$) (Snedecor and Cochran, 1980).

Preparation of organic manures extract:

Fresh chicken, plant compost and farmyard manure were obtained from trusted poultry and animal farms in Ismailia City, where the animals or chicken were not fed with hormones or manufactured diets for poultry feed. The manures was placed in burlap bags (2 kg/bag), then the bags was placed in plastic drums filled with water (20 liters/drum), a rock was added to each bag of manure to make sure it did not float.150 g of molase + 10 g of magnesium sulphate/drum were added. Then, the drums were covered with plastic wraps to complete the fermentation process. After three weeks of fermentation, the organic manures extract were ready to be used.

Table (2): Chemical properties of chemical composition of chicken manure tea, plant compost and farmyard (1:10 extraction) manure extracts

Parameters	Ch.ME	CME	FME
pH	7.56	7.61	7.61
EC ($ds.m^{-1}$)	1.34	1.40	1.45
Total N (ppm)	1263	989	479
Phosphorus (ppm)	1375	979	987
Potassium (ppm)	1987	1887	1089
Mg (ppm)	620	606	592
Ca (ppm)	291	222	183
Fe (ppm)	7.52	6.88	5.90
Cu (ppm)	3.01	3.12	2.81
Zn (ppm)	2.11	2.02	1.72
Mn (ppm)	0.09	0.07	0.07

Ch.ME = chicken, CME= plant compost and FME= farmyard

Measurements: The following determinations were recorded during both experimental seasons.

- Leaf N, P, K, Mg and Ca contents: 16 mature leaves from the meddle part of the non-fruiting shoots from each tree were picked at full blooming stage. The leaves were dehydrated at 80°C overnight, ground to fine powder. Nitrogen was determined by kjeldhal method and phosphorus was determined colourmetrically. Leaf K, Ca and Mg contents were determined using atomic absorption spectrophotommetry (Perkin Elmer 280) according to Martin-Préval *et al.* (1984).
- Fruit weight (g) and number per tree were recorded at harvesting time, and then the average yield (kg/tree) was calculated. Two fruits from each side of the tree at harvesting time were taken to determine fruit physical properties, *i.e.* fruit height (cm), fruit diameter (cm) and flesh thickness (cm); the same fruits were used to determined total soluble solids (TSS %), total sugars % and total acidity (TA %) according to AOAC (2000). L-Ascorbic acid (vitamin C; mg/100 g) fresh weight of fruit pulp was determined by titration with 2-6 Dichlorophenol-Indophenol. Pectin was extracted and determined by precipitation as calcium pectate (mg/100 g) (Ranganna, 1985).

RESULTS AND DISCUSSION

Effect of organic manure on leaves mineral contents:

Data presented in Table (3) indicated that in both experimental seasons (2019 and 2020), spraying guava trees with Ch.ME, CME and FME, individually or in combination, significantly increased leaf nitrogen, phosphorus, potassium, and magnesium contents compared to the untreated trees. However, non-significant differences were observed in leaves Ca %, except those of the second seasons where the mixture of the three organic manures gave higher and significant Ca % than the control or other treatments. Using any combination of the three organic manures had a superiority effect on leaves NPK and Mg than using any one alone, during the two experimental seasons. The maximum values were recorded on the trees that received the mixture of the three organic manures (Ch.ME + CME + FME). On the other side, the untreated trees produced leaves with the lowest N, P, P and Mg contents, during the two experimental seasons.

Using organic manures achieved many important functions when sprayed on the fruit trees at the optimum concentration. This may be attributed to the higher content and availability macro and micro nutrients organic manures. Ibrahim *et al.,* (2015) in clay soil under El-Minia Governorate conditions found that leaf macronutrients (N %, P %, and K %) were significantly enhanced as a results of mango trees cv. Keitte fertilization four times/year with organic manure with or without Royal jelly and seaweed extract.

Table (3): Effect of foliar spray of chicken, compost and farmyard manures extract on leaves mineral contents (%) of guava, during 2019 and 2020 seasons

Treatments	N %		P %		K%		Ca %		Mg %	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	1.20	1.22	0.14	0.13	1.25	1.23	1.42	1.40	0.35	0.39
Ch.ME	1.43	1.45	0.21	0.23	1.44	1.46	1.44	1.42	0.41	0.44
CME	1.41	1.44	0.20	0.21	1.43	1.43	1.45	1.44	0.47	0.49
FME	1.35	1.37	0.19	0.21	1.39	1.41	1.42	1.43	0.42	0.42
Ch.ME + CME	1.76	1.82	0.28	0.29	1.52	1.54	1.45	1.47	0.59	0.61
Ch.ME + FM E	1.73	1.80	0.24	0.26	1.49	1.53	1.44	1.46	0.52	0.54
CME + FME	1.69	1.77	0.26	0.26	1.41	1.44	1.42	1.47	0.52	0.55
Ch.ME + CME +FME	1.92	1.99	0.31	0.31	1.66	1.72	1.45	1.78	0.66	0.71
New LSD $_{0.05}$	0.12	0.14	0.03	0.05	0.18	0.17	NS	0.15	0.05	0.06

Effect of organic manure extract on yield and its components:

As shown in Table (4) in both seasons (2019 and 2020) spraying the three organic manures three times yearly on guava trees significantly increased fruit weight and fruit number/tree and consequently higher yields (kg./tree) were attained as compared to the control trees. The highest values of these measurements were recorded for trees sprayed with the mixture of the three organic manures (Ch.ME + CME + FME) in combination, followed by those received the mixture of Ch.ME + CME.

During fermentation and decomposition of organic fertilizers, some growth regulators are produced, as well as availability of many nutritional elements are increased. In addition to, production of some chelating compounds that save these elements from loss. All these features may be resulted the positive effect on yield and its components which has been observed in guava trees. Results of some previous studies on other evergreen fruit trees may be confirmed the role of organic fertilization in enhancing yield and its components which obtained in this study such as: Baiea and El-Gioushy (2015) on Grand Naine banana cultivated in sandy soil at El-Katatba region, Minofia - Egypt, Ibrahim *et al.* (2015) on Keitte Mango trees grown under El-Minia region environmental conditions, Egypt, Abd El-Hamid and El-Shazly (2019) on Sukkary mango trees grown in sandy soil at North Sinai environmental conditions, Egypt, Meya *et al.* (2020) on Banana plant cultivated in volcanic soil under North Tanzania.

Table (4): Effect of foliar spray of chicken, compost and farmyard manures on fruits number/tree, average fruit weight (g) and yield (kg/tree) of guava trees, during 2019 and 2020 seasons

Treatments	No. of Fruits/tree		Fruit weight (g)		Yield (kg/tree)	
	2019	2020	2019	2020	2019	2020
Control	224.3	221.1	129.2	121.3	28.97	26.82
Ch.ME	247.5	251.5	145.5	158.3	36.10	39.81
CME	239.3	243.7	132.7	133.3	31.76	32.49
FME	234.7	248.2	139.3	150.2	32.69	37.28
Ch.ME + CME	268.6	282.4	168.2	123.4	44.86	34.85
Ch.ME + FME	269.8	275.5	155.3	159.7	41.80	43.99
CME + FME	256.3	263.3	154.3	151.2	39.55	39.81
Ch.ME + CME +FME	272.4	282.5	168.5	171.3	45.98	48.39
New LSD $_{0.05}$	38.4	30.1	17.4	16.5	4.10	5.12

Effect of organic manure extract on fruit physical and chemical properties:

Data concerning the effect of three sprays of the three examined organic manures on the physical and chemical properties of guava fruits during 2019 and 2020 seasons are presented in Tables (5 and 6). It is clear from these Tables that treating Balady guava trees with the three organic manures tea (Ch.ME, CME and FME) significantly was accompanied with improving fruit height (cm), fruit diameter (cm) fruit pulp thickness (cm), TSS %, Total sugars %, Ca-pectat (mg/100g D.W) and vitamin C (mg/100g F.W.) and decreased total acidity %, relative to the untreated trees, during the two experimental seasons. The combined application of the three organic manures (Ch.ME, CME and FME) showed more effectiveness in improving the physical and chemical properties of Balady guava trees followed by spraying Ch.ME and CME. On the onsite side untreated trees produced fruits with lowest fruit physical and chemical properties, during the two experimental seasons.

At is well known that organic manure fermentation and decomposition produced and liberties some growth regulators and nutritional elements, such as IAA, cytokines, N, K, B and Zn. In addition organic manure decomposition producing some chelating compounds that can save the elements from loss (Mengel, 1985; Marschner, 1995; Mengel, 2007; Ibrahim *et al.,* 2015; Meya *et al.,* 2020). The aforementioned roles of organic manure tea could be explanted its effect on improve fruit physical and chemical properties that clearly showed in the present study. Similar results were found by other authors under Egyptian conditions such as, Omar *et al.* (2012) on Washington Navel orange under clay loam soil at Jafre El-Sheikh region conditions; Baiea and El-Gioushy (2015) on Grand Naine banana cultivated in sandy soil at El-Katatba region; Ibrahim *et al.* (2015) in Keitte Mango trees grown under El-Minia region environmental conditions, and Abd El-Hamid and El-Shazly (2019) on Sukkary mango trees grown in sandy soil at North Sinai conditions. Similar findings were obtained in volcanic soil at Tanzania by Meya *et al.* (2020) on Banana plant.

Table (5): Effect of foliar spray of chicken, compost and farmyard manure extracts on fruit physical of guava fruits, during 2019 and 2020 seasons

Treatments	Fruits height (cm)		Fruit diameter (cm)		Pulp thickness (cm)	
	2019	2020	2019	2020	2019	2020
Control	7.25	7.19	5.79	5.82	1.23	1.21
Ch.MT	7.78	7.89	5.98	6.12	1.39	1.42
CMT	7.56	7.71	5.87	6.04	1.33	1.38
FMT	7.44	7.52	5.81	5.99	1.32	1.35
Ch.MT + CMT	7.99	8.01	6.22	6.24	1.52	1.59
Ch.MT + FMT	7.87	7.91	6.12	6.15	1.44	1.51
CMT + FMT	7.79	7.83	6.01	6.13	1.45	1.42
Ch.MT + CMT +FMT	8.02	8.14	6.38	6.59	1.64	1.69
New LSD $_{0.05}$	0.19	0.21	0.09	0.11	0.11	0.11

Table (6): Effect of foliar spray of chicken, compost and farmyard manure extracts on fruit chemical properties of guava fruits, during 2019 and 2020 seasons

Treatments	TSS %		Sugars %		Total acidity %		Vitamine C (mg/100g F.W)		Ca pectat (mg/100g D.W.)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	8.32	8.73	6.55	6.41	1.109	1.107	78	81	7.12	7.16
Ch.MT	9.21	9.32	7.40	7.56	0.918	0.907	88	89	9.0	9.8
CMT	9.11	9.20	7.19	7.43	0.938	0.921	81	86	8.6	8.9
FMT	9.04	9.13	7.02	7.31	0.978	0.971	83	86	8.0	8.4
Ch.MT + CMT	9.75	9.77	7.88	7.98	0.836	0.821	95	98	11.1	12.0
Ch.MT + FMT	9.49	9.57	7.53	7.72	0.851	0.832	91	93	10.5	10.8
CMT + FMT	9.34	9.39	7.40	7.61	0.862	0.841	89	93	10.1	10.6
Ch.MT + CMT +FMT	9.99	10.33	8.06	8.48	0.801	0.789	99	106	12.1	13.2
New LSD $_{0.05}$	1.8	1.7	1.2	1.1	0.022	0.041	3.5	4.3	0.6	0.5

CONCLUSION

In order to improve the nutritional status, productivity and fruit physical and chemical properties of guava trees, based on the obtained results it may be highly recommended to spray the trees three times yearly with the three organic manures namely; chicken (Ch.ME), plant compost (CME) and farmyard manure extracts (FME). This observation was markedly pronounced in the trees sprayed with the mixture of the three organic manures extract (Ch.ME + CME + FME).

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تحسين الحالة الغذائية والإنتاجية وجودة الثمار لأشجار الجوافة البلدي باستخدام مستخلص بعض الأسمدة العضوية رشاً على الأشجار

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من أجل دراسة استجابة إنتاجية أشجار الجوافة وجودة ثمارها لرش مستخلص ثلاثة أسمدة عضوية هي: السماد البلدي الكمبوست زرق الدواجن. أجريت التجربة الحقلية الحالية خلال موسمي متتاليين هما ٢٠١٩ و ٢٠٢٠ على أشجار جوافة بلدي عمرها عشرة سنوات نامية في أراضى رملية جيرية بمزرعة خاصة بطريق القاهرة إسكندرية الصحراوي على بعد ٧٠ كيلومتر من مدينة القاهرة - مصر. تم رش أشجار الجوافة البلدي ثلاثة مرات بمستخلص الأسمدة الثلاثة: المرة الأولى عند بداية النمو الخضري (في أول مارس) والمرة الثانية بعد عقد الثمار مباشرة (في بداية شهر أبريل) والمرة الثالثة بعد شهر من المرة الثانية. وقد أوضحت النتائج المتحصل أن الرش الفردي أو المشترك لمستخلص الأسمدة العضوية الثلاثة سواء بصورة فردية أو مشتركة قد أدى إلى حدوث زيادة معنوية في محتوى الأوراق من العناصر الغذائية (النيتروجين والفوسفور والبوتاسيوم والماغنسيوم)، في حين أن رش مستخلص الأسمدة الثلاثة لم يكن لها تأثير معنوي على محتوى الأوراق من الكالسيوم فيما عدا المعاملة المشتركة للثلاثة أسمدة معاً في الموسم الثاني فقط. هذا وقد أدى رش مستخلص الأسمدة العضوية الثلاثة كلاً بمفردة أو المعاملات المشتركة بينهم إلى حدوث زيادة معنوية واضحة في كمية المحصول محسوبة كعدد الثمار على الشجرة ومتوسط وزن الثمرة بالجرام وذلك بالمقارنة بالأشجار الغير معاملة. كما أدت المعاملة بمستخلص الأسمدة العضوية الثلاثة إلى حدوث تحسن معنوي في الصفات الفيزيائية لثمار الجوافة البلدي متمثلة في تحسن ارتفاع وقطر الثمرة وكذلك سمك لب الثمار، كما أدت هذه المعاملات إلي حدوث تحسن معنوي أيضاً في الصفات الكيميائية للثمار متمثلة في زيادة نسبة المواد الصلبة الذائبة في عصير الثمار ونسبة السكريات الكلية وفيتامين ج (بالمجم/١٠٠ جرام لب) كما أدت المعاملات إلى خفض نسبة الحموضة بعصير الثمار بصورة معنوية، وذلك خلال موسمي الدراسة. وكانت أفضل المعاملات في هذا الصدد هي رش مستخلص الأسمدة العضوية الثلاثة معاً ثلاث مرات خلال العام.