Global Advanced Research Journal of Agricultural Science (ISSN: 2315-5094) Vol. 9(5) pp. 087-099, May, 2020 Issue.
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Full Length Research Paper

Soil Fertility Nutrition and Size of the Fruit of Guava with Liquid Organic Fertilizers

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Accepted 15 May, 2020

In Calvillo, Aguascalientes, guava is produced more than 100 years ago. In order to improve soil fertility, promote plant growth and improve fruit quality, during 2014-2016 the experiment was carried out. The fruit manure was prepared, manure tea and compost tea, each applied to the soil, foliage and soil and foliage plus a witness, each treatment was repeated 4 times and a completely randomized design was used, the experimental unit was a two-year-old tree of The "China" variety. Applications were made every eight days. Soil treatments caused significant differences (P < 0.05) in Da, MO and N. The P increased with the treatments applied to the soil and foliar and the K, Ca and Mg, were excessive. In the soil solution the TéCS increased by 3.5 mg/kg, N and Na at 16.45 mg/kg. In leaves the Na increased by 57.4 mg/kg and in fruit the treatments TéEF, TéCFS and AFF increased their size. It is concluded that liquid organic fertilizers are a good ecological alternative to improve soil fertility and guava nutrition.

Keywords: Guava, fertility, nutrition, organic fertilizers

INTRODUCTION

Guava (Psidium guajava L.) belongs to the family Myrtaceae, its ecological area is between the parallels 30 ° of latitude to the north and south of the equator (ALFONSO PARRA-CORONADO, 2014). México, is considered center of diversity of the species by the wide variability existing (Singh, Gill, Boora, and Arora, 2015). It adapts to different soils and climates, it can behave like deciduous tree and evergreen at the same time, according to the availability of water.

Guava was introduced more than a century ago to the municipality of Calvillo, Aguascalientes and in 1948 to the Juchipila Canyon, Zacatecas, the most important guava producing area in Mexico with 62.6% of the surface planted at the national level (Arif, Chaudhary, Agarwal, & Kamra, 2015).

The degradation of the soil is a direct consequence of the wrong laboring as the irrational use of chemical fertilizers, elimination of organic waste and consequently impoverishment of the soil in organic matter (Sanzano, La Bella, García, & Fadda, 2005). The chemical degradation consists in the decrease of soil fertility and occurs when the nutrient inlet is lower than its output by crops, fires and leaching (Ciampitti, 2008). The physical degradation of the soil is the destruction of the structure by

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Table 1. Characterization of plants at the beginning of the investigation

Hileras	**A** m	**DT** cm	**DR** cm	**NF**	**NC**	**NFr**
1	1.92	2.5	1.8	1	9	6
2	1.91	2.8	2.0	1	17	1.5
3	1.94	1.8	1.8	11	12	0
4	2.00	2.3	1.7	2	26	4
5	1.80	2.0	1.8	1.8	17	0
6	2.00	3.0	3.0	0	8	8
7	1.90	2.6	2.7	11	39	1
8	1.80	2.5	2.7	1.5	16	36
9	1.90	2.0	1.9	0	35	4
10	2.10	2.8	3.9	1.5	21	12

The values indicated are the average of four plants. A = height (m), DT = trunk diameter (cm), DR = diameter of branches (cm), NF = number of flowers, NC = number of cruisers and NFr = number of fruits

the rupture of the soil aggregates, the pores are sealed with fine material, making it difficult to infiltrate the water (Rucks, García, Kaplan, Ponce de León, & Hill, 1994).

There are testimonies attesting to the beneficial effect of liquid organic fertilizers on the improvement of the nutrient reserve of the soil (Galindo, Jerónimo, Spaans, & Weil, 2007), (Ochoa-Martínez et al., 2009). With the application of liquid organic fertilizers in the cultivation of rice (Oriza sativa L.) Excellent results have been achieved in the quality and yield, also in the cultivation of bean (Phaseolus vulgaris L.), in plant height at 30 days. Under controlled conditions in tomato cultivation (Lycopersicum esculentum L.) They applied liquid humus to the soil and leaves, finding a positive response in terms of dry matter content in plants, number of leaflets, root volume and dry weight of roots (Arif et al., 2015). Also (Castellanos & Pratt, 1981) point out that the humic amendments favor rooting, as they develop and maintain a youthful and vigorous root system throughout the crop cycle. The root development of the plant with the contribution of humic amendments is enormous, and this makes growth much faster, because it absorbs more nutritious elements, and increases production. In this same sense (Cabrera Torres, Sosa Rubio, Castellanos Ruelas, Gutiérrez Baeza, & Ramírez Silva, 2009), indicate the stimulating effect of humic acids on the formation of roots by accelerating the differentiation of the growth point. Therefore, the research was aimed at improving soil fertility, favoring plant growth and improving the fruit quality of guava (Psidium guajava L.), in response to the application of liquid organic fertilizers.

MATERIALS AND METHODS

Location and characteristics of the place

The experiment was carried out during 2014, 2015 and 2016 in a guava orchard located in San Tadeo in the municipality of Calvillo, Aguascalientes, México, with coordinates 21 ° 55 latitude North and 102 ° 41 ´ Longitude West at an altitude of 1801 msnm. The climate is semi-warm, with an annual average precipitation of 660 millimeters, of irregular occurrence, the average annual temperature fluctuates between 18 and 22 °C and a potential evapotranspiration that reaches values of 2500 millimeters per year. Traditionally, groundwater extraction has been used in this area by pumping for irrigation purposes, but water resources are scarce and medium-quality every year.

Selection of Trees

In the investigation, 40 trees of 2 years and a half of age were used, planted at a distance of 7m x 7m with irrigation by micro-sprinkler with two sprinklers per tree, the expenditure per emitter was of 4 liters per hour and a frequency of application of 1 time per week. In the orchard, 10 contiguous rows of trees were taken, each one was assigned a treatment, four uniform trees were labeled and each tree was an experimental unit, pruning was performed and the variables indicated were measured at the beginning (Table 1).

Treatment design.10 treatments were defined each treatment was repeated 4 times and a completely

Table 2. Treatments, Key and description

Treatments	Key	description
1	Té ES	Manure tea applied to the soil
2	Té CS	Compost tea applied to the soil
3	AFS	Fruit manure applied to the soil
4	Té EF	Manure tea applied to foliage
5	Té CF	Compost tea applied to foliage
6	AFF	Fruit manure applied to foliage
7	Té ESF	Manure tea applied to the soil and foliage
8	Té CSF	Compost tea applied to the soil and foliage
9	AFSF	Fruit manure applied to the soil and foliage
10	T	Control (no application)

randomized design was used, the experimental unit was a tree (Table 2).

Soil sampling

Were taken four sub-samples of soil in the area covering the treetops half-distance from the trunk to the cup-edge, with N-S and E-O orientation at a depth of 0 to 20 cm, a Oakfield-type auger was used for soil sampling (38 mm diameter by 216 mm long), the extracted soil was deposited on a blanket, it was mixed manually and by peeling it was divided eliminating two opposite rooms until leaving approximately one kilo of compound sample. In the laboratory the samples were spread on absorbent paper for drying at room temperature, with good ventilation and in the shade. Once dried, they were passed through a sieve mark Retsch of 2 mm mesh, to obtain a homogeneous particle size. Each sample was determined the variables: pH, with table peachmeter model SM-3BW pH range 0.00-14.00 Accuracy ± 0.01, in a solution soil: water 1:2 (w/v); CE, with conductivity, model Amprobe WT-20 in term of soluble salts dS/m; CIC, by the ammonium acetate method 1N to pH 7, in reference to the capacity that has a soil to retain and release positive ions. The MO by the method of Walkley-Black, N with Semimicro-Kjeldahl distillation, P method Olsen, K was quantified by flame emission spectrophotometry, Ca and Mg were quantified by ammonium acetate 1.0 N pH 7 and atomic absorption spectrophotometry; Fe, Cu, Zn and Mn by DTPA and atomic absorption and B by Fotocolorimetría of Azomethine-H.

Soil solution sampling

Prior to the installation of the probe in the field, it was caused to empty up to 70-80 centibar with suction pump. The capsule was immersed in a container with water and left for 12 hours. The probe consists of a PVC cylinder attached to a porous cylindrical-shaped porcelain capsule with a semi-spherical terminal, through which the soil solution penetrates when applying a pressure difference by vacuum. The PVC cylinder is in turn sealed by a rubber stopper, which crosses a small diameter tube and semirigid walls that connect to the vacuum system. The sample was collected in 240 ml plastic bottles with a screw-cap.

The sampling consisted of loading the probe, creating a depression of 70 cbar 24 hours before the next irrigation and collecting the sample a moment before it. The mechanism as the solution of soil passes to the capsule, is similar to the mechanism of passive absorption of the plants, this makes that it can be considered as reference method when a culture intervenes.

Foliar sampling

Foliar sampling was performed 6 months after pruning and organic fertilizer to ensure an adequate nutrimental state of the plants, as well as vigorous appearance and healthy appearance; Because plants that have been subjected to some kind of stress should not be used; To this end, 20 recently ripe leaves from the periphery and middle of the treetops were taken from each plant. The samples were placed in plastic bags for transport to the laboratory in a cooler, then washed with distilled water and dried to the environment, in order to eliminate any residue that might interfere with the chemical analysis. Subsequently, they were weighed in a Mettler Pc 4400 scale (the weight was expressed in grams ± 0.01) to obtain the fresh mass (MF), and proceeded to place them in a stove at 65 °c for a period of 24 to 48 hours until they obtained constant mass and then ground. Then, 1 gram of the sample obtained from each plant was taken, forming a composite sample for each group, the preparation of this material (ground sample) and the analytical methods used were carried out according to the procedures indicated by the A.O.A.C.. Nitrogen (N) was determined by the Kjeldahl method,

Table 3. Chemical analysis of liquid organic fertilizers

Abono	**N**	**P**	**Ca**	**Mg**	**Na**	**K**	**Fe**	**Cu**	**Mn**	**Zn**
AF	9.7	10.9	201.3	29.5	71.5	1300.1	60.1	0.1	4.3	1.3
TéC	2.3	0.2	49.1	13.2	125.8	591.4	1.1	0.1	0.2	0.4
TéE	56.2	12.6	270.5	28.0	536.7	3285.7	5.2	0.7	0.4	0.7

AF = fruit manure, TéC = Compost tea, TéE = Manure tea. N = nitrogen, Micro-Kjenhdal (mg/l); P = phosphorus, ammonium Molybdate (mg/l); Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, Fe = iron, Cu = copper, Mn = manganese and Zn = Zinc by Atomic absorption (Mg/L).

Table 4. Physical-chemical analysis of soil

Treatments	Sand %	Silt %	Clay %	Clase textural	Da (g/cm^3)	MO (1.6-3.5 %)	pH (6.6-7.3 moles/l)	CE dS/m
TéEF	14.4	24.0	61.6	Arcillosa	1.080 b	2.66 bcde	7.4 a	2.249 ab
TéES	18.4	22.0	59.6	Arcillosa	1.112 b	3.53 abc	7.4 a	2.274 a
TéEFS	12.4	16.0	71.6	Arcillosa	1.129 ab	3.33 abcd	7.5 a	2.201 ab
TéCF	20.4	16.0	63.6	Arcillosa	1.112 b	4.07 a	7.4 a	1.491 b
TéCS	14.4	18.0	67.6	Arcillosa	1.119 ab	3.66 ab	7.4 a	1.921 ab
TéCSF	12.4	16.0	71.6	Arcillosa	1.119 ab	2.52 cde	7.5 a	2.192 ab
AFF	6.4	22.0	71.6	Arcillosa	1.119 ab	1.98 e	7.6 a	2.268 a
AFS	20.4	20.0	59.6	Arcillosa	1.168 a	2.49 cde	7.5 a	1.506 b
AFFS	18.4	20.0	61.6	Arcillosa	1.169 a	2.32 de	7.5 a	1.884 ab
Testigo	14.4	22.0	63.6	Arcillosa	1.168 a	2.42 de	7.6 a	1.967 ab
Significancia					*	**	ns	ns

Treatments: foliar Manure Tea (TéEF); Soil Manure Tea (TéES); Leaf Manure and Soil tea (TéEFS); Foliar Compost Tea (TéCF); Compost Tea soil (TéCS); Soil and foliar Compost tea (TéCSF); Foliar fruit Manure (AFF); Soil fruit Manure (AFS); Foliar and soil fruit manure (AFFS); Witness, no credit. Physico-chemical Variables: sand%, silt% and clay%, Bouyoucos method, Da = apparent density (g/cm3) test tube, MO = organic matter% Walkey and Black, pH ratio 1:2 potentiometer, CE = electrical conductivity dS/m conductivity. Significance between treatments: NS = Not significant, * = significant (F > P 0.05) and * * = highly significant (F > P 0.01).

Values with the same letter within the columns are statistically the same, according to Fisher's LSDα = 0.05 method and a confidence of 95%

Phosphorus (P) by the Meta-vanadate-molybdate method of ammonium, potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) by the flame photometry spectrum method. The results were expressed as the concentration of minerals by dry mass (DM) (grams of mineral/100 grams of dry matter).

For the statistical analysis, the Minitab 17 package was used, analysis of variance and mean comparison tests were performed for the variables with significant results ($P < 0.05$), the physico-chemical variables of the soil by means of the test LSDα = 0.05 and for the Chemical variables of the soil and foliar solution, the Tukey test, 0.05, was used.

RESULTS AND DISCUSSION

Chemical analysis of liquid fertilizers showed that manure tea resulted in a higher concentration of N, P, Ca, Na, K and Cu (mg/l); It was followed by the fruit manure with elevated contents of N, P, Ca, Mg, K, Fe, Mn and Zn (mg/l) and finally the compost tea with the exception of the Na content (Mg/l) was the poorest (Table 3).

Physical-chemical Variables of the soil

Soil belongs to the clayey textural Class (Table 4); the texture is a property that directly affects the bulk density, because as the soils are compacted, the porosity decreases and the density increases, as indicated (Rosemary, Vitharana, Indraratne, Weerasooriya, & Mishra, 2017).

The treatments caused significant differences ($P < 0.05$) in bulk density (gr/cm3) and the mean comparison test LSDα = 0.05 indicated three groups; within each group the treatments are statistically equal and between groups are different. The group (A) was integrated by the treatments AFS, AFFS and control, the group (AB) by the treatments TéEFS, TéCS, TéCSF, AFF and the group (B) by the treatments TéEF, TéES, TéCF. This showed high apparent

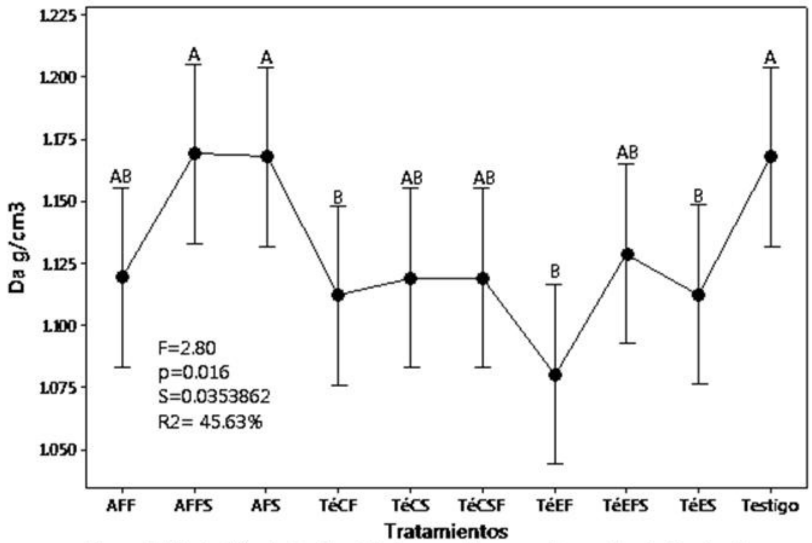

Figura 1. Variación de la densidad aparente causada por los tratamientos

density with the fruit manure applied to the AFS soil, as well as applied to the soil and AFFS foliage and control (Rosemary et al., 2017), while the rest of the fertilizers reduced it (Table 4; Figure 1). Low apparent density values are typical of porous soils, with good air and water circulation and easy root penetration. As mentioned (bigger, Bary, Myhre, Fortuna, & Collins, 2016), the apparent density is a dynamic property that varies with the structural conditions of the soil, the aggregation in the soils tends to increase the porous space therefore decreases the density Apparent. The high apparent density values are typical of compact and low-porous soils, with poor aeration and slow water infiltration.

The fertilizers caused significant differences ($P < 0.01$) in the percentage of MO; Mean comparison was made with the method LSDα = 0.05, resulted in the formation of eight groups (Table 4), the first (a) by the treatment TéCF; The second (AB) by the TéCS treatment, the third (ABC) by the treatment TéES, the fourth (ABCD) by the treatment TéEFS, the fifth (ABCDE) by the treatment TéEF, the sixth (CDE) by the treatments TéCSF and AFS, the seventh (of) by the treatments AFFS and control , finally the eighth (e) for the AFF treatment. This result showed that with the exception of fruit manure treatments applied to the AFF foliage and fruit manure applied to the foliage and the AFFS soil, compared to the control the treatments increased the percentage of MO in the soil, highlighting the compost tea A applied to TéCF foliage which recorded an increase of 1.65% (Table 4; Figure 2). Likewise confirms it (Lordn et al., 2015) and agrees with the NOM-021-RECNAT-2000, which establishes an average content of MO for values that are between 1.6-3.5%.

In pH (moles/L) No differences were found ($P > 0.05$) caused by the treatments (Table 4); However the test of comparison of average LSD α = 0.05 showed that in the manures tea fertilizer applied to the foliage TéEF, tea of manure applied to the soil TéES, tea of compost applied to the foliage TéCF and tea of compost applied to the soil TéCS the pH , it is in the range of Neutrality 6.5 – 7.4 (moles/L) and in the rest of the treatments slightly alkaline 7.5 – 7.9 (Moles/L) (Lordin et al., 2015).

In EC dS/m No differences were found ($P > 0.05$) of treatments, the mean comparison test LSDα = 0.05 identified three groups. The group (a) was integrated by the TéES and AFF treatments, the (AB) treatments TéEF, TéEFS, TéCS, TéCFS, AFFS and Control and the (b) for treatments TéCF and AFS and showed that the manure tea applied to the foliage TéEF, increased the EC at 0282 dS/m , manure tea applied to soil TéES at 0307 dS/m, manure tea applied to foliage and soil TéEFS in 0234 dS/m Compost tea applied to the soil and foliage TéCSF at 0235 dS/m and fruit manure applied to the AFF foliage at 0301 dS/m (Table 4). These results indicate that the fertilizers did not cause increases in the salts that could cause some problem in the plant. The analysis of the EC in soils is done to establish if the soluble salts are in sufficient quantity to affect the normal germination of the seeds or the absorption of water by the plants. The accumulation of soluble salts in the soil is attributed mainly to problems of drainage and to the action of continuous irrigations, followed by evaporation and drought as it points out (Ibekwe, Ors, Ferreira, Liu, & Suarez, 2017).

Table 5. Assessment of nutrients in the soil with the influence of liquid fertilizers

TRAT	**N (10-20 mg/kg)**	**P (15-25 mg/kg)**	**K (175-280 mg/kg)**	**Ca (1000-2000 mg/kg)**	**Mg (60-180 mg/kg)**	**Na mg/kg**
TéEF	17.09 abc	12.54 ab	1426 ab	3095 ab	562.8 ab	121.6 a
TéES	12.21 bc	5.78 b	1305 ab	2877 ab	504.4 b	107.7 a
TéEFS	6.24 c	14.52 ab	1392 ab	3636 a	543.8 ab	152.2 a
TéCF	9.66 c	13.86 ab	1089 b	2710 b	517.1 ab	107.3 a
TéCS	8.41 c	7.42 ab	1300 ab	2835 ab	551.1 ab	158.9 a
TéCSF	8.68 c	15.34 ab	1267 b	2895 ab	536.1 ab	141.5 a
AFF	13.83 abc	11.22 ab	1861 a	3230 ab	611.1 a	177.9 a
AFS	24.95 ab	11.22 ab	1332 ab	2812 ab	463.7 b	118.4 a
AFFS	26.9 a	16.66 a	1367 ab	2867 ab	539.6 ab	109.0 a
Testigo	8.63 c	11.39 ab	1488 ab	3470 ab	536.5 ab	107.9 a
Significancia	*	ns	Ns	ns	ns	ns

…. Cont. Cuadro

TRAT	**CIC** (Cmol/kg)	**Fe** (2.5-5.0 mg/kg)	**Mn** (>2 mg/kg)	**Zn** (>1.5 mg/kg)	**Cu** (>2.0 mg/kg)	**B** (0.5-2.0 mg/kg)
TéEF	24.27 ab	9.26 ab	8.987 abc	0.3005 b	0.1925 ab	0.2800 b
TéES	22.33 ab	11.09 ab	10.50 ab	0.3985 ab	0.1895 ab	0.4000 ab
TéEFS	26.87 a	12.31 ab	9.319 abc	0.604 a	0.2140 a	0.300 b
TéCF	21.05 b	14.67 a	12.23 a	0.4080 ab	0.1710 a	0.640 a
TéCS	22.71 ab	7.28 b	6.29 bc	0.2535 b	0.1405 bc	0.2400 b
TéCSF	22.15 ab	6.676 b	4.924 c	0.2340 b	0.13000 c	0.2400 b
AFF	26.51 a	6.60 ab	4.88 c	0.2200 b	0.1450 bc	0.320 b
AFS	22.38 ab	7.47 b	6.05 bc	0.2500 b	0.1775 abc	0.1200 b
AFFS	22.54 ab	10.51 ab	8.51 abc	0.3225 b	0.1920 ab	0.1600 b
Testigo	25.82 ab	8.73 ab	8.48 abc	0.2980 b	0.1735 abc	0.220 b
Significancia	ns	ns	*	ns	ns	ns

Treatments: foliar Manure Tea (TéEF); Soil Manure Tea (TéES); Leaf Manure and Soil tea (TéEFS); Foliar Compost Tea (TéCF); Compost Tea soil (TéCS); Soil and foliar Compost tea (TéCSF); Foliar fruit Manure (AFF); Soil fruit Manure (AFS); Foliar and soil fruit manure (AFFS); Witness, no credit. N = Total Nitrogen Micro-Kjenhdal (mg/kg), P = phosphorus available Olsen (mg/kg), K, Ca, Mg and interchangeable Na (mg/kg). CIC = cationic Exchange Capacity (Cmol/kg), significance between treatments: NS = Not significant, * = significant (F ≤ p 0.05). Values with the same letter within the columns are statistically the same, according toFisher's LSDα = 0.05 method and a confidence of 95%

Nutrient content in the soil

The fertilizers caused significant differences ($P < 0.05$) in the content of N, the comparison of means LSDα = 0.05 formed five groups (Table 5, Figure 3), the (a) was integrated by the treatment fruit manure applied to the foliage and to the soil AFFS, the (AB) by the treatment fertilizer Fruit applied to the AFS soil, the (ABC) for the treatments foliar fruit, AFF and leaf manure tea TéEF, the (BC) for the treatment of manure to the soil TéES and the (c) by the treatments of foliar manure and soil TéEFS , TéCF foliar compost tea, compost tea TéCS soil, compost

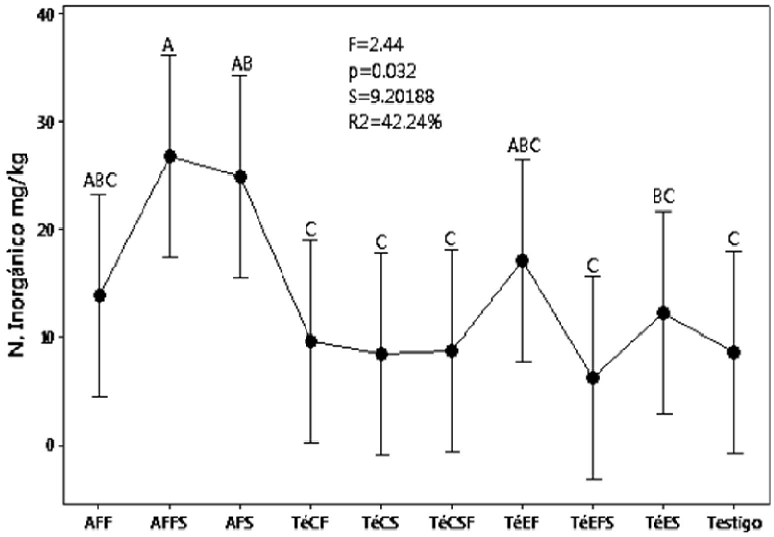

Figura 3. Variación de nitrógeno inorgánico en el suelo causado por los tratamientos

tea soil and foliar CSF and control; Compared to the witness, it was evident that the fruit manure applied to the foliage and the AFFS soil increased it by 18.27 mg/kg, fruit manure applied to the AFS soil, at 16.32 mg/kg, fruit manure applied to the AFF foliage at 5.0 mg/kg , the foliar manure tea TéEF at 8.46 mg/kg, the manure tea applied to the soil TéES at 5.2 mg/kg and the foliar Compost Tea (TéCF) at 1.03 mg/kg. These results suggest that organic production is promising (bigger et al., 2016).

The analysis of variance did not detect differences ($P > 0.05$) in content of P, K, Ca, Mg and Na in the soil, however for these elements was performed the comparison of mean LSDα = 0.05 and P were formed groups (a) with the treatment AFFS , the (AB) with the compost tea treatments soil and foliar TéCSF, soil and foliar manure tea TéEFS, TéCF foliar compost tea, TéEF foliar manure tea, foliar fruit, AFF manure, fruit manure, AFS soil, TéCS soil compost tea and control; and (b) by the treatment of TéES soil manure. The differences encountered compared to the witness were: fruit leaf and AFFS soil bonus at 5.27 mg/kg, foliar compost tea and TéCSF soil at 3.95 mg/kg, foliar manure tea and TéEFS soil at 3.13 mg/kg, TéCF foliar compost tea at 2.47 mg/kg and Foliar Manure Tea TéEF at 1.15 mg/kg (Table 5). These results are supported by those reported by (Horrocks, Curtin, Tregurtha, & Meenken, 2016). For K groups (a) were formed with the treatment of foliar fruit AFF, the (AB) with control treatments, TéEF foliar manure tea, foliar manure tea and TéEFS soil, foliar fruit manure and AFFS soil, AFF foliar fruit manure, TéES soil manure Tea , fruit manure AFS floor and compost tea soil TéCS; and (b) by treatment of TéCF foliar compost; And it was evidenced with respect to the control, that the foliar fruit fertilizer AFF, increased it in magnitude of 373 mg/kg (Table 5).

For Ca, the groups (a) were formed by the treatment TéEFS, the (AB) by the treatments AFF, TéEF, control, TéCSF, TéCS, TéES, AFS, and the (b) by the treatment TéCF; And it was evident that the treatment TéEFS increased by 163 mg/kg (Table 5).

For Mg, the groups (a) were formed by the AFF treatment, the (AB) by the treatments TéEF, TéCS, TéEFS, AFFS, TéCSF, control, TéCF and the (b) by the treatments AFS and TéES; It was evident that the AFF increased it by 74.6 mg/kg (Table 5).

For Na formed the group (a) to which all the treatments belong and it was evidenced that the AFF treatment increased it by 70 mg/kg, the TéCS at 51 mg/kg and the TéCSF in 33.6 mg/kg (Table 5).

The treatments increased the content of Mn ($P < 0.05$) in the soil, the comparison test of mean LSDα = 0.05 showed that the treatment TéCF increased by 3.75 mg/kg, also increased Zn at 0.3 mg/kg and based on a value of sufficiency > 1.5 mg/kg, is appreciated Insufficiency in the soil, although the Cu increased slightly, its content is poor since it was not > 2, while the B with sufficiency range of 0.5-2, the result indicates that it is in the lower limit of sufficiency.

Nutrients in the soil solution

The nutrient concentration in the soil solution is generally low (Table 6), as it refers (Ibekwe et al., 2017) who assessed an average µ M concentration of nutrients in the solution in the arable layer (0-20 cm) of an agricultural soil in: pH 7.7, K 510, Ca 1650, Mg 490, N-NH4 48, N-NO3

Table 6. Nutrient content in the soil solution

TRAT	N (mg/l)	Na (mg/l)	**Cu** (mg/l)	**Zn** (mg/l)	**pH (moles/l)**
TéEF	14.875 bc	32.95 b	0.010 a	0.010 a	6.875 b
TéES	14.000 bc	38.70 ab	0.002 a	0.000 a	7.350 ab
TéEFS	12.070 c	48.85 a	0.005 a	0.005 a	7.675 a
TéCF	16.270 abc	36.25 ab	0.005 a	0.002 a	7.525 a
TéCS	20.300 a	43.42 ab	0.010 a	0.000 a	7.400 ab
TéCSF	16.275 abc	42.20 ab	0.005 a	0.000 a	7.675 a
AFF	15.400 abc	35.42 b	0.005 a	0.000 a	7.500 a
AFS	15.925 abc	33.93 b	0.002 a	0.000 a	7.850 a
AFFS	18.030 ab	35.00 b	0.000 a	0.000 a	7.675 a
Testigo	16.800 abc	32.40 b	0.000 a	0.007 a	7.650 a
Significancia	**	**	*	*	**

Treatments: foliar Manure Tea (TéEF); Soil Manure Tea (TéES); Leaf Manure and Soil tea (TéEFS); Foliar Compost Tea (TéCF); Compost Tea soil (TéCS); Soil and foliar Compost tea (TéCSF); Foliar fruit Manure (AFF); Soil fruit Manure (AFS); Foliar and soil fruit manure (AFFS); Witness, no credit.
N = nitrogen (mg/l), Na = Sodium (mg/l), Cu = Copper (mg/l), Zn = Zinc (mg/l), and pH (moles/L). Significance, * = significant, * * = highly significant ($F \leq p$ 0.05). Values with the same letter within the columns are statistically the same, according to Fisher's LSDα = 0.05 method and a confidence of 95%.

3100, S-SO4 590, P-PO4 1.59, Zn 0.48 and Mn 0.002. The treatments contributed in the content of N ($P < 0.01$), the test of comparison of mean LSDα = 0.05 showed that the treatment TéCS, with respect to the control increased the concentration in 3.5 mg/L, and Na also increased ($P < 0.01$), indicating that the treatment TéEFS increased it by 16.45 mg/l (Table 6, Figures 4 and 5).

The nutrients are transported by the water towards the proximity of the roots by mass flow, the motive force is the perspiration of the plant. The quantity of nutrient transported is the result of the solution volume (V0) multiplied by the concentration of the nutrient in the solution (CL) FM = V0 * CL. For this mechanism to be efficient the amount of nutrient required must be small or the concentration of the nutrient in the solution should be very high. Mg, N-NO3-and S-SO42-are mainly absorbed by this mechanism. Once they reach the surface it may occur that the plant absorbs water but not nutrients, which accumulate and may precipitate.

Effect of treatments on nutrimental content in guava leaves

The plants respond to the foliar application of liquid organic fertilizers, when applied to the foliage of the crops, it allows to increase the amount of roots and increase the photosynthesis capacity of the plants, improving substantially the production and quality of The Harvest (Prado & Natale, 2004).

(Chetri, Sanyal, & Kar, 1999), found that foliar content of N and K was low in the course of the growing season and increased in August reaching the maximum from September to December, with no significant effects on foliar content of P, with some Exceptions, the Mg content exhibited a behavior similar to Ca. The leaves of Allavad Safe showed markedly high contents of K, Ca and Mg in CV Luknow-49.

In guava (Psidium guajava L.), as in other species, the nutrimental composition of the leaves varies with age and their position in the shoots, the type of outbreak (vegetative or reproductive) and the phenological state of the tree. For example, the values of N, P, K, Zn and Cu in guava leaves decrease as the leaf increases in age, and Ca, Mg and Mn increase, but they stabilize at five months of age (sink, Singh, & Singh, 2007). In order to make a preliminary diagnosis and derive critical levels and nutrient sufficiency ranges in guava leaves, (de Oliveira, Hafle, Mendonca, Moreira, & Mendonca, (2013) with the aim of proposing a preliminary diagnosis of the standards Of the integrated Diagnostic and Recommendation system (DRIS) and derive critical levels and nutrient sufficiency ranges in guava leaves; They found that the nutrient-limiting deficiencies in descending order were: N > Cu > P = K > Mn > Fe = Zn> S > B = Mg > Ca, and the elements limiting by excess in descending order were: B > Ca > Fe > Mn > S > Cu > P > Zn > N = K. The appropriate index ranges DRIS were: N (24-48), P (2.4-3.1), K (21-29), Ca (6-8), Mg (1.9-2, 9) and S (1.9-2, 3) G/kg respectively (Antunes, Scoriza, Da Silva, & Correia, 2016). Other researchers reported that the sufficiency ranges of nutrients derived from the DRIS norms were: N (1.41-1.65%), P (0.10-0.17%), K (0.51-0.97%), Ca (1.16-2.12%), Mg (0.31-0.51%) and S (0.18-0.28%) (Hundal et al., 2007).

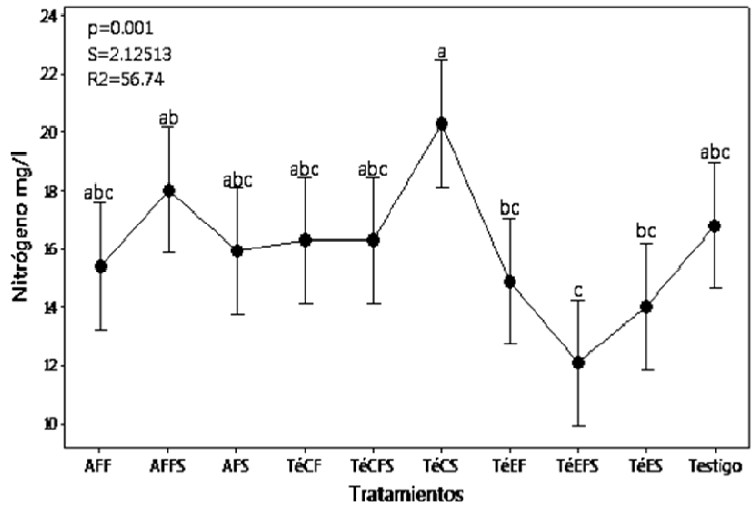

Figura 4. Contenido de Nitrógeno en la solución del suelo

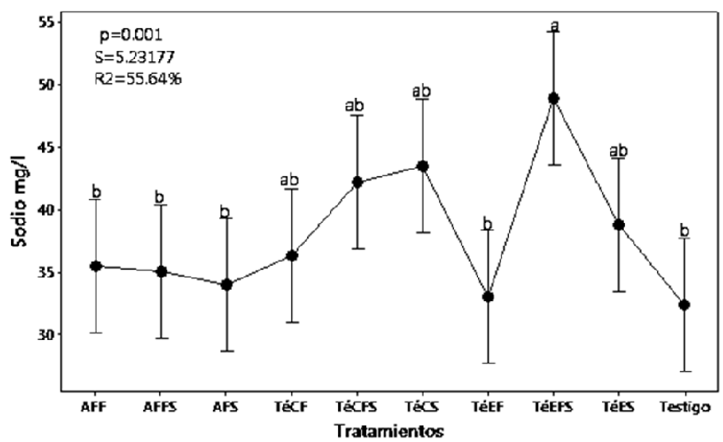

Figura 5. Contenido de Sodio en la solución del suelo

The fertilizers did not increase the P content in the leaves, the results indicate percentages inferior to the control, however significant differences were detected (F 0.05 = 3.05 > P = 0.010) between the treatments and the comparison of means (Tukey, 0.05) formed three Groups: (a), (AB) and (b). According to the diagnosis of the DRIS nutrient balance, in the groups (a) and (AB) the foliar content of P was found in the sufficiency range (0168-0236%) With the treatments: control, AFFS, TéCSF, TéES and TéEF and insufficient in the group (b) with the treatments TéEFS, TéCF, TéCS, AFF and AFS (Table 7).

In foliar Ca its content was found within the range of sufficiency (0.60-1.27%) reported by Anjaneyulu & Raghupathi, 2009, highlighting the TéEF treatment under which an excessive content was recorded, surpassing in 44% the control.

In Mg, treatment effect was not evidenced, in all cases, it was insufficient to satisfy the requirements of the plant.

The fertilizers did not increase the content of K in the leaves, however significant differences were detected (F 0.05 = 6.80 > P = 0.000) between the treatments and the comparison of means (Tukey, 0.05) formed three groups: (a), (ab) and (b). According to the diagnosis of the nutrient balance DRIS, indicated by Anjaneyulu & Raghupathi, 2009; the foliar content was inferior to the optimum (1.20 to 1.67%).

In Table 7, it is observed that in the foliar content of P, Mg, Fe, Cu and Mn, the fertilizers did not contribute. In P, the Tukey, 0.05 mean comparison test, indicates differences between treatments, but the highest value corresponds to the control (without fertilizer), this result reports that in the leaves the concentration values are close to the lower limit of the Sufficiency Range (0.14-0.18%). In Ca the manure tea treatment applied to foliage (TéEF) increased by 0.44%. In K the manure tea treatment applied to foliage (TéEF), it increased by 0.41%, the treatment of manure applied to the soil (TéES) in 0.39%, the manure tea applied to the soil and foliage (TéEFS) in 0.50%, the compost tea applied to the foliage (TéCF) in 0.26%, Compost tea applied to soil (TéCS) in 0.34%,

Table 7. Effect of liquid fertilizers on nutrimental content in guava leaves

Tratamientos	P %	Ca %	Mg %	K %	Fe (mg/kg)	Cu (mg/kg)	Mn (mg/kg)
TéEF	0.17 ab	1.60 a	0.21 a	1.09 a	83.30a	4.55a	48.78 a
TéES	0.17 ab	1.10 ab	0.16 a	1.05 a	80.88a	4.27a	36.15 a
TéEFS	0.15 b	0.96 ab	0.17 a	1.18 a	78.35a	5.07a	36.80 a
TéCF	0.14 b	1.10 ab	0.19 a	0.94 ab	106.5a	5.25a	59.4 a
TéCS	0.13 b	0.89 ab	0.17 a	1.02 ab	82.1a	3.95a	42.13 a
TéCSF	0.19 ab	0.90 ab	0.17 a	1.05 a	72.10a	4.95a	48.45 a
AFF	0.15 b	0.76 b	0.18 a	0.98 ab	73.13a	4.25a	39.83 a
AFS	0.15 b	0.74 b	0.18 a	0.69 b	93.3a	4.62a	40.50 a
AFFS	0.19 ab	0.86 ab	0.17 a	0.68 b	129.4a	4.25a	54.85 a
Testigo	0.23 a	1.16 ab	0.20 a	0.68 b	78.03a	4.82a	59.63 a

Treatments: TéEF = leaf manure tea; TéES = soil manure tea; TéEFS = leaf manure tea and soil; TéCF = foliar Compost tea; TéCS = Compost tea soil; TéCSF = Compost tea soil and foliar; AFF = foliar fruit manure; AFS = fruit manure soil; AFFS = foliar and soil fruit manure; Control = no fertilizer. P (Wind-molybdate); Ca, Mg, K, Fe, Cu and Mn (atomic absorption).

Sufficiency ranges: P (0.168-0.236%); Ca (0.60-1.27%); Mg (0.35-0.50%); K (1.20 to 1.67%); Fe (114-178 mg/kg); Cu (6-12 mg/kg). Mn (34-77 mg/kg).

Table 8. Nutrimental sufficiency ranges derived from the DRIS standards reported by several authors

Referencia	N%	P%	K%	Ca%	Mg%
1	1.41-1.65	0.10-0.17	0.51-0.97	1.16-2.12	0.31-0.51
2	1.42-2.31	0.092-0.134	0.32-0.66	1.70-3.40	0.19-0.32
3	1.69-2.19	0.168- 0.236	1.20- 1.67	0.60-1.27	0.35-0.50
4	1.8-2.0	0.12-0.16	1.46-2.08	1.13-1.69	0.25-0.31

1= (Hundal et al., 2007); 2=(Beyhan, Bozkurt, & Boysal, 2011); 3=Anjaneyulu & Raghupathi, 2009; 4=(Kotur, Ramkumar, & Singh, 1997).

…….. Continuación cuadro anterior

Referencia	S%	Fe mg/kg	Mn mg/kg	Zn mg/kg	Cu mg/kg
1	0.18-0.28	105-153	58-110	15-29	6-16
2	--	70-148	18-63	6.70-11.10	1.32-2.88
3	0.29-0.47	114- 178	34-77	29- 41	6-12

1= (Hundal et al., 2007); 2=(Beyhan, Bozkurt, & Boysal, 2011); 3=Anjaneyulu & Raghupathi, 2009.

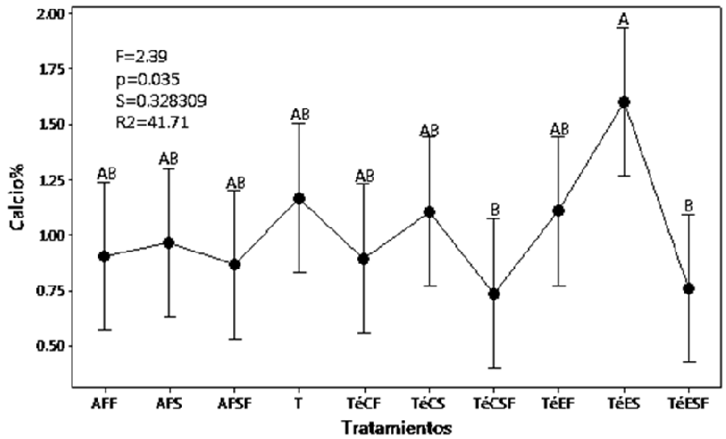

Figura 6 Contenido de Calcio en las hojas

Table 9. Effect of liquid fertilizers on the nutrimental balance in guava leaves (P. Guajava)

Tratamientos	P%	Ca%	Mg%	K%	Fe mg/kg	Cu mg/kg	Mn mg/kg
TéEF	D	E	B	B	B	B	O
TéES	D	O	B	B	B	B	O
TéEFS	B	O	B	B	B	B	O
TéCF	B	O	B	B	B	B	O
TéCS	B	O	B	B	B	B	O
TéCSF	O	O	B	B	B	B	O
AFF	B	O	B	B	B	B	O
AFS	B	O	B	B	B	B	O
AFFS	O	O	B	B	O	B	O
Testigo	O	O	B	B	B	B	O

B = Low (smaller value to the lower limit of the sufficiency range), D = deficient (value at the lower limit of the sufficiency range), O = optimal (value within the sufficiency range), A = high (value at the upper limit of the sufficiency range) and E =excessive (Value higher than the range of sufficiency).

Table 11. Effect of liquid fertilizers on guava fruit size

Tratamiento	P/F (g)	DP (cm)	DE (cm)	Categoría
TéEF	100.1 a	6.250 a	5.525 a	Extra
TéES	ND	ND	ND	ND
TéEFS	58.6 a	5.225 a	4.694 ab	Primera
TéCF	38.0 a	3.800 a	3.700 b	Segunda
TéCS	ND	ND	ND	ND
TéCSF	116.9 a	6.771 a	5.786 a	Extra
AFF	108.5 a	6.612 a	5.738 ab	Extra
AFS	62.7 a	6.300 a	4.733 ab	Primera
AFFS	74.0 a	5.633 a	5.067 ab	Primera
Testigo	73.3 a	5.793 a	4.962 ab	Primera

Leaf Manure Tea (TéEF) soil Manure tea (TéES); Leaf Manure and Soil tea (TéEFS); Foliar Compost tea (TéCF; Compost tea soil (TéCS; Soil and foliar Compost tea (TéCSF); Foliar fruit Manure (AFF); Soil fruit Manure (AFS); Fertilizer of foliar fruits and soil (AFFS and without fertilizer (control). Weight per fruit P/F (g), polar diameter DP (cm), equatorial diameter (cm). ND = not determined.

compost tea applied to foliage and soil (TéCSF) in 0.37% and fruit manure applied to foliage (AFF) in 0.30%. In Na the fruit manure treatment applied to foliage (AFF), increased by 57.4 mg/kg. These results in contradictory appearance are due to the sampling time, which was carried out in the flowering stage because in the fruiting period of guava, the values of K are low, which is attributed to its mobilization towards the fruit s, similar tendencies of N, P and K have also been observed in plants of this species, because their values are higher in the fruitful shoots than in the vegetative ones. The foliar content of K, Ca and Mg also varies between dates, so that by decreasing K, it increases Ca and, to a lesser degree, Mg (Da Silva, De Araujo, Martins, Martins, & Seey, 2016). For guava, it is recommended to sample between the third and fifth knots from the apex, whereas (Bharat & Das, 2017) indicated that leaves of four to eight months of age of the middle part of the vegetative buds should be sampled. On the other hand, the results obtained are based on the optimal values of nutrients, but without considering the conditions of climate, soil and nutrimental source with which the intervals were generated, so these recommendations can vary between sites and Authors.

Morphological Variables in guava leaves

The shape of the sheet (FH) was elliptical in the treatments: foliar Manure Té (TéEF), foliar compost tea (TéCF) and foliar fruit Manure (AFF) and Oblong in treatments: manure tea on the ground (TéES), foliar manure tee and Soil (TéEFS), compost soil (TéCS), compost soil and foliar tea (TéCSF), fruit manure on the ground (AFS), leaf fruit manure and soil (AFFS) and control (without fertilizer). The sheet margin (MH) was flat in all treatments. The shape of the apex (AF) was acute. The shape of the round base (FB) and the length of the petiole (LP) was less than 1 cm. The weight of leaves (PH) varied in the range of 1,032 G (TéES) to 1,553 G (TéEF). The length of the Blade (LH) was large (> to 10 cm), existing correspondence with the width of the leaf (AH), the ratio of the length-width ratio (L/A) of Leaf was taken as an indicator of the shape of the leaf, being in the category of median (greater or equal to 1.5 cm and less or I Gual to 3.0 cm) resulting in median in all cases. The foliar area was estimated by multiplying the length by width (L * A), resulting in the range of 46.7 (TéES) to 59.1 cm2 (TéCSF).

Fruit size

For the classification by size of the fruit the following categorization was used: Extra (ϴ ≥ 5.3 cm), first (ϴ ≥ 4.3 and ϴ ≤ 5.3 cm.), second (ϴ> 3 cm, and ϴ ≤ 4.2 cm.) and third (ϴ< 3 cm.). In Table 7, it is appreciated that the foliar manure tea (TéEF), soil and foliar compost tea (TéCSF) and foliar fruit Manure (AFF) produced extra-sized fruits. Treatments: Fruit fertilizer and soil (AFFS), control (without fertilizer), fruit manure on the ground (AFS) and leaf manure tea and soil (TéEFS) produced first-size fruits.

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