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Fruit production and quality of guava 'Paluma' as a function of humic substances and soil mulching

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The uses of humic substances and organic residues for soil mulching have been more common during last years. This way, an experiment was carried out to evaluate the fruit quality and yield of guava cv. Paluma as a function of humic substances and organic soil mulching in Brazil. The experiment was performed from January 2012 to June 2013 (first trial) and from July to November 2013 (second trial) using a randomized blocks with treatments distributed in a factorial arrangement (5 × 2 × 2) of five humic substances doses (0, 10, 20, 30 and 40 mL of Humitec plant^{-1}), two organic mulching use (with and without organic mulching) and two consecutive harvests, with four replications of two plants each. Humic substances enhance fruit production more efficiently in guava plants grown without soil mulching. Guava fruit production increases from the first to the second harvest. Fruit quality for titratable acidity, soluble solids, vitamin C and soluble solids/titratable acidity ratio is adequate independently of soil mulching use. Humic substances improve fruit quality of guava cv. Paluma. Under soil and climate conditions, and considering the first two production cycles of guava, it is possible to recommend about 20 mL L^{-1} of humic substances for production of high quality guava fruits.

Key words: Humic acids, post-harvest, *Psidium guajava*.

INTRODUCTION

Fruit production is an important horticultural activity that increases employment availability, makes possible the family establishment in the field, promotes a better income distribution within productive cycle besides it acts as promising expectations of Brazilian and foreign markets. Among the economically important fruit crops, guava (*Psidium guajava* L.) presents high viability for farmers, especially for expansion of production areas in

Brazil (Amorim et al., 2015a).

The increasing consumption of fresh and processed fruits, including guava, is a worldwide tendency that stimulates the production of quality fruits (Amorim et al., 2015b). In Northeastern Brazil, guava crop in economically important especially in irrigated areas of Bahia and Pernambuco states where water potential, soil and climate conditions are favorable for growing guavas commercially using horticultural technologies for water and nutrient management (IBGE, 2014; Rodrigues et al., 2015).

Paluma is one of the high quality guava cultivars available for Brazilian guava farmers, and one of the most widespread throughout Brazil. Guava detaches among other tropical fruits for its attractive features of fruits such as color, pleasant smell and taste, mineral composition, high lycopene content and possibilities of consumption, attributes that guarantee preference for different consumer markets worldwide, especially because guava fruit has been consumed as fresh or processed fruit (Ramos et al., 2010; Amorim et al., 2015a).

Despite the social and economic importance of Brazilian guava, there is little information on soil fertilizing management for production of fruit quality fruits and high yields. This scientific shortage is worse for small and medium farmers, the majority in Northeastern Brazil (Silva et al., 2009). Accordingly, Serrano et al. (2007) reported that it is necessary to use more intensive management systems for irrigation and fertilizing management of guava trees (Natale et al., 2011; Amorim et al., 2015b).

Concern about agricultural sustainability is evident in recent years worldwide. This way, the soil quality maintenance is one of the essential factors for a sustainable production system, which demands an adequate soil management as main component. Nowadays guava farmers have also invested for simultaneous fertilization of mineral and organic fertilizers, emphasizing the use of humic substances in crop management (Souza et al., 2014; Silva et al., 2015).

The agricultural techniques for water loss reduction and, consequently, increase water use efficiency aim to reduce losses by evaporation using soil mulching that reduces water loses through air evaporation, decreases soil temperature and maintains soil moisture for longer time in addition to providing nutrients after decomposition of plant material (Silva et al., 2013; Bakshi et al., 2015). Soil mulching has been used for production of fruits and vegetables in Brazil and worldwide providing viability to the production system, especially where water availability is limited (Sarkar and Singh, 2007; Silva et al., 2013).

Hence, the present study aimed to evaluate the fruit quality and yield of guava cv. Paluma as a function of humic substances and organic soil mulching in Brazil.

MATERIALS AND METHODS

Plant material and growth conditions

Guava (*P. guajava*) plants cv. Paluma propagated by cuttings were used in this study. The study was carried out from January 2012 to June 2013 (first trial) and from July to November 2013 (second trial) on the Macaquinhos experimental farm of Federal University of Paraiba, Remigio County, Paraiba State, Brazil (Northeastern Brazil).

During the execution of the experiment, the climatic data were collected by a meteorological station installed inside the experimental farm (Table 1), while physical and chemical characteristics of the soil before the experiment are in Table 2. The soil is a Xerorthent (Ultisol - American classification Soil Taxonomy).

One year old guava plants, spaced with 3 m between the rows and 3 m between the plants, were daily micro-sprinkle irrigated with one emitter per plant, for a flow of 60 L h^{-1}, following the daily evaporation recorded in a class A tank corrected through Kc value (0.75) defined by Ferreira et al. (2010) for guava. All agronomic practices performed in the experiment for pruning, control of pests, diseases and weed, followed the instructions of Natale et al. (2009).

During the execution of the experiment, all the plants were fertilized with 1.166 kg ha^{-1} of urea (45% of N) and 1.166 kg ha^{-1} of potassium chloride (60% K_2O) monthly; and 467 kg ha^{-1} of fosmag (18% of P_2O_5) bimonthly according to the instructions by Natale et al. (2009).

The humic substances used in the experiment were extracted from leonardite, and the source adopted was Humitec (Tradecorp™), whose complete composition included humic extract (16.5%), organic carbon (11.2%), humic acids (13.2%) and fulvic acids (3.3%).

Treatments and experimental design

The experiment was randomized blocks with treatments distributed in a factorial arrangement (5 × 2 × 2) of five humic substances doses (0, 10, 20, 30 and 40 mL of Humitec $plant^{-1}$), two organic mulching use (with and without organic mulching) and two consecutive harvests, with four replications of two plants each.

The humic substances doses were defined following the recommendations of the producer, that is, 30 mL diluted in 6 L of water applied every 60 days after pruning, reaching 18 applications for each experiment. Organic mulching was composed of dehydrated *Brachiaria decumbens* with a layer of 5.0 cm.

Variables recorded and statistical analyses

During the fruit harvest time, that is, August 2012 to January 2013 and April to November 2013, 10 fruits per parcel were manually harvested (still firm) at intermediate green color (yellow-green color) placed in plastic boxes and taken to the Laboratory for post-harvest fruit quality analyses. This harvest parameter for fruit selection was recommended by Hojo et al. (2007) for commercial farms.

The fruit analyses of the guava fruits followed the instructions of

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Table 1. Average precipitation, air temperature and air humidity during the experiments.

Month	2012			2013		
	P[1] (mm)	AT[2] (°C)	AH[3] (%)	P[1] (mm)	AT[2] (°C)	AH[3] (%)
January	141	26.5	66	38	26.7	59
February	112	24.4	56	66	24.9	45
March	8	23.9	72	41	24.9	68
April	36	23.8	76	135	24.7	70
May	75	23.2	79	58	24.2	76
June	195	22.3	86	155	22.4	80
July	106	22.5	92	118	22.0	82
August	17	21.15	86	82	21.5	86
September	4	24.4	78	30	24.7	78
October	7	27.2	63	13	27.4	62
November	0	27.4	54	21	28.7	54
December	0	27.3	56	43	28.2	56

[1]Precipitation, [2]air temperature, [3]air humidity.

Table 2. Chemical and physical characteristics of the soil (0-20 and 20-40 cm soil depth) where the experiment was carried out.

Soil characteristic	0-20 cm	20-40 cm
pH (in water)	5.02	5.03
	$cmol_c\ dm^{-3}$	
Ca^{2+}	0.98	0.24
Mg^{2+}	0.50	0.76
Al^{3+}	0.08	0.22
$H^{+} + Al^{3+}$	2.68	1.98
CEC	4.33	3.11
P (mg dm^{-3})	5.31	1.69
K (mg dm^{-3})	68.01	50.78
	%	
Organic matter	0.73	0.40
Al^{3+} saturation	1.88	7.61
Basis saturation	38.11	36.33
	g kg^{-1}	
Clay	788	732
Silt	106	130
Sand	106	138
Soil density (kg dm^{-3})	1.62	1.60
Particle density (kg dm^{-3})	2.67	2.69
Micro porosity ($m^3\ m^{-3}$)	0.14	0.15
Macro porosity ($m^3\ m^{-3}$)	0.25	0.25
Available water (%)	7.87	7.81

P, K: Mehlich 1; $H^{+} + Al^{3+}$: calcium acetate (extractor) 0.5 M pH 7; Al^{3+}, Ca^{2+}, Mg^{2+}: KCl 1 M extractor; CEC: cationic exchangeable capacity.

Instituto Adolfo Lutz (2008) and included the usual parameters: i) the fruit mass was measured using a Sartorious™ (Göttingen, Germany) brand precision balance (0.01 g precision) and expressed in g; ii) for the titratable acidity (TA), 20 g of macerated fruit pulp was taken from yellow passion fruits and brought to a final volume of 100 mL by adding distilled water. A 20 mL sample was taken from the mixture; and three to four drops of phthalein were used as an indicator. This suspension was titrated with 0.1 N sodium hydroxide (NaOH). The results were expressed as a percentage; iii) the soluble solids (SS), expressed as °Brix, were measured using an Abbe™ refractometer (Bausch and Lomb, Rochester, NY, USA); iv) The vitamin C content was defined with 5 g of fruit pulp taken from acerola and brought to a final volume of 100 mL by adding distilled water plus 1 mL of 1% amid solution. A 20 mL sample was taken from the mixture and titrated with 1 N iodine. The results were expressed in mg 100 g^{-1} of fresh fruit; v) the pulp pH was measured using a Marconi™ pH meter; vi) after chemical analyses, the relation between the soluble solids and the titratable acidity (SS/TA ratio) was calculated; and vii) the fruit yield were measured as ton ha^{-1}.

Statistical analysis

Statistical analyses included analysis of variance (ANOVA), a mean separation of mulching using the Tukey test and regression analysis of the humic substances doses of two consecutive harvests. All calculations were performed using the Sigmaplot software, and the terms were considered significant at $P \leq 0.01$.

RESULTS AND DISCUSSION

As shown in Table 3, fruit production (kg $plant^{-1}$) was affected by humic substances x soil mulching interaction. For fruit quality variables, the humic substances × soil mulching × harvest interaction was significant for fruit mass, soluble solids and titratable acidity. Vitamin C and pH average values were affected by humic substances x harvest interaction (Table 3).

For plants grown without soil mulching, humic substances doses increase from 0 to 21 mL L^{-1} enhanced guava fruit production from 28.5 to 33.1 kg $plant^{-1}$, followed by a consecutive decay, while plants grown with

Table 3. Variance analysis for fruit production (FP) and fruit quality [fruit mass (FM), pH, soluble solids (SS), vitamin C (Vit. C), titratable acidity (TA) and SS/TA ratio] of guava as a function of humic substances and soil mulching.

Variance analysis	FP	FM	pH	SS	Vit. C	TA	SS/TA
HS	51572792.95^{ns}	201.36^{ns}	0.06^{ns}	3.06*	59.60*	0.003^{ns}	81.87^{ns}
SM	30482274.05^{ns}	1387.19*	0.15*	0.32^{ns}	3.67^{ns}	0.005^{ns}	57.95^{ns}
Trial (T)	233605.94**	189245.59**	6.45**	12.70**	1594.27**	0.20**	4120.02**
HS × SM	117385974.45**	806.07*	0.01^{ns}	12.31**	24.21^{ns}	0.004^{ns}	203.32**
HS × T	19692028.58^{ns}	248.1^{ns}	0.12**	2.01^{ns}	140.88**	0.009*	17.72^{ns}
SM × T	14499342.05^{ns}	1098.97*	0.04^{ns}	6.09*	56.56^{ns}	0.001^{ns}	56.83^{ns}
HS × SM × T	446745845.58^{ns}	828.91*	0.01^{ns}	4.32**	32.27^{ns}	0.011**	73.98^{ns}
Residual	23368245.25	255.91	0.03	1.01	21.05	0.003	38.60
CV (%)	14.99	16.41	4.36	13.76	28.73	19.24	22.28

HS: Humic substances; SM: soil mulching; **significant at P<0.01 probability error; *significant at P< 0.05 probability error; ns: non-significant; CV: coefficient of variation.

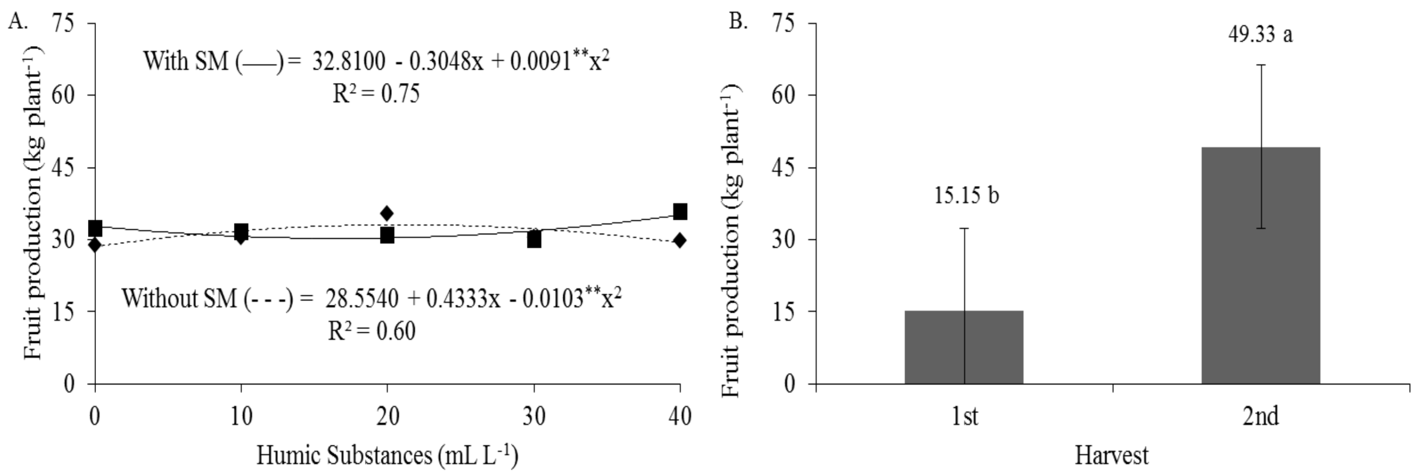

Figure 1. Fruit production of guava plants as a function of humic substances and soil mulching (SM) (A) in two consecutive harvests (B).

soil mulching had fruit production decrease until 16.8 mL L^{-1}, followed by an increase until it reached the maximum fruit production of 35.2 kg $plant^{-1}$ at the highest humic substances dose (Figure 1A). Guava fruit production increased significantly from the first (15.15 kg $plant^{-1}$) to the second (48.33 kg $plant^{-1}$) harvest showing superiority of 225.6% (Figure 1B).

The benefits of humic substances on guava fruit production occurred in congruency to the adequate management practices of the orchard for pests control, diseases control, pruning, water supply and fertilizer management, especially using a slow releasing fertilizer, more efficient on nutrient supply. In addition, Souza et al. (2014) reported enhancement of fruit production of guava cv. Paluma with increasing doses of by-product of guava processing industry from a 1089.65 to 1327.19 kg $plant^{-1}$ in six cumulative harvests.

At the first harvest, humic substances doses increasing without soil mulching enhanced fruit mass until it reached a calculated peak at 19.7 mL L^{-1}, corresponding to 135.1 g, while for plants with soil mulching, fruit mass decreased from 142.6 to 129.1 g (Figure 2A). At the second harvest, humic substances doses increase without soil mulching promoted a fruit mass linear increase from 173.7 to 196.4 g, while for plants with soil mulching, fruit mass was enhanced until the stemmed average of 15.6 mL L^{-1}, corresponding to the individual fruit mass of 197.0 g. This data distribution indicate fruit mass increase of 13.1 and 3.5% as a function of humic substances with and without soil mulching, respectively (Figure 2B). The fruit mass reduction for higher humic substances doses occurred due to the higher number of fruits per plant (data not presented), a characteristic known in the scientific literature for guavas (Ramos et al., 2010).

Fruit pH enhanced with humic substances doses increase in the first harvest, reaching 3.54 at 20.8 mL L^{-1}, but an inverse data distribution was registered in the

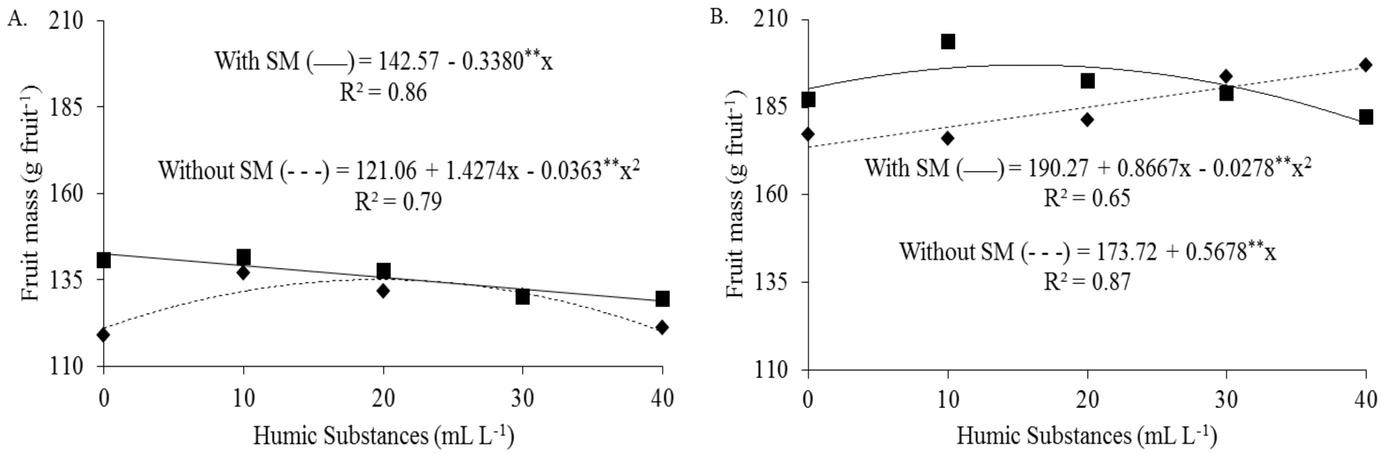

Figure 2. Fruit mass (A and B) of guava as a function of humic substances and soil mulching (SM) in two consecutive harvests.

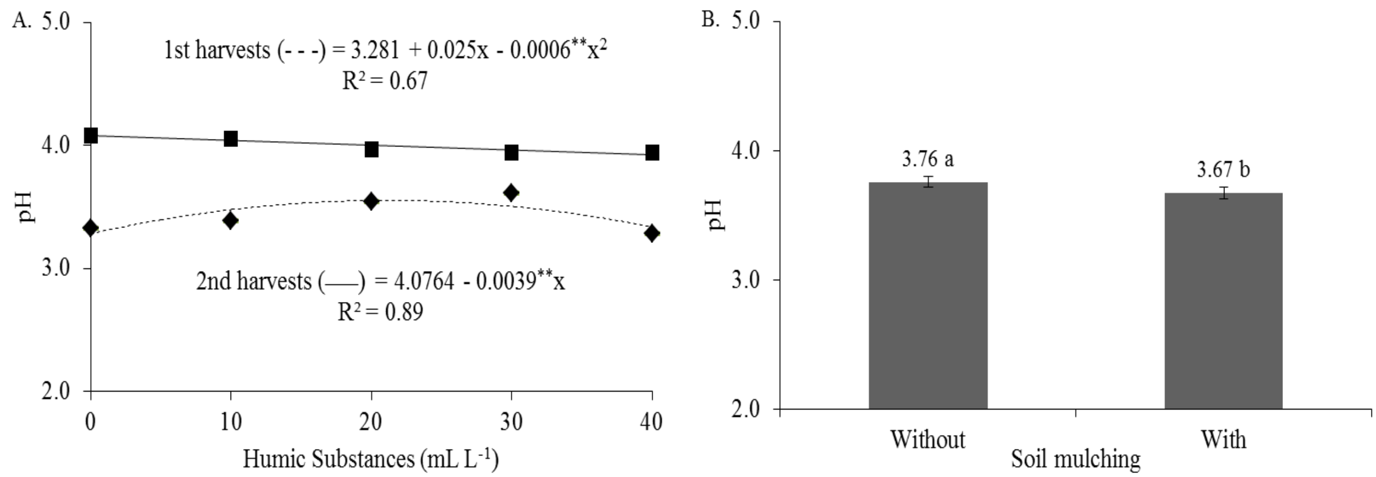

Figure 3. Fruit pH of guava as a function of humic substances and soil mulching (SM) (A) in two consecutive harvests (B).

second harvest, that is, a fruit length linear decrease of 0.0039 mm per unitary enhancement of humic substances (Figure 3A). Beyond pH average reduction, the lower pH value of the second harvest was 10.7% higher than that recorded in the first harvest. As shown in Figure 3B, there was reduction in fruit pH from 3.76 to 3.67, caused by soil mulching. According to Ramos et al. (2010), fruit pH higher than 3.5 needs addition of organic acids for fruit processing. High pH shows possible deterioration of industrialized products because the maximum limit is 4.2 for better product conservation. According to Mariano et al. (2011), fruit pH is used to evaluate acid characteristic and shelf life of fruits. Campos et al. (2007) reported that less acid fruits are more recommended for consumption as fresh fruit, while more acid fruits are required for food industry.

In the first harvest, fruits produced without soil mulching presented a soluble solids linear increase of 0.0244 per unitary enhancement of humic substances reaching 8.1 °Brix, which corresponds to an enhancement of 12.5% in relation to those fruits produced without humic substances (Figure 4A). Soluble solids of fruits produced with soil mulching decreased with humic substances doses increase until the lower average value of 5.56 °Brix, recorded at 20.76 mL L^{-1} (Figure 4A). In the second harvest, soluble solids values was enhanced with humic substances doses increase until reaching a peak at 8.6 and 7.5 °Brix referring to 17.8 and 25.4 mL L^{-1}, without and with soil mulching, respectively. These results are above 9.33 °Brix reported by Ramos et al. (2011), and lower than 10.08 at 10.48 °Brix reported by Ramos et al. (2010).

In the first harvest, plants grown with soil mulching presented a titratable acidity linear increase of 0.0004% per unitary enhancement of humic substances reaching 0.27% (Figure 4C), while for fruits produced without soil

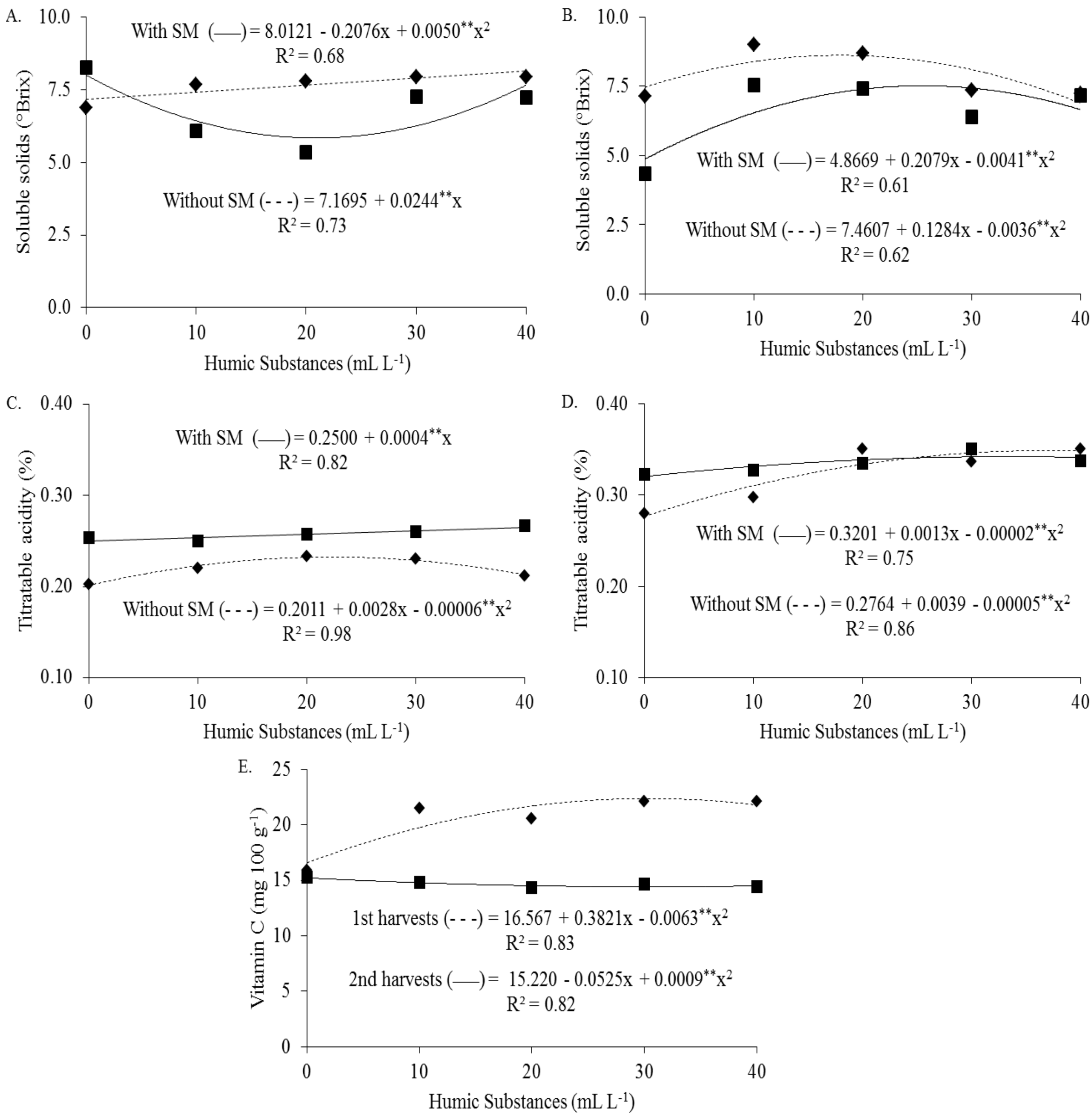

Figure 4. Fruit soluble solids (A and B), titratable acidity (C and D) and vitamin C (E) of guava as a function of humic substances and soil mulching (SM) in two consecutive harvests.

mulching, titratable acidity increased until 0.23% at 23.3 mL L^{-1}. In the second harvest, titratable acidity of fruits produced without and with soil mulching increased until 0.35 and 0.34%, with regards to calculated doses of 39.0 and 32.5 mL L^{-1}, respectively (Figure 4D). The 0.23 at 0.35% range recorded in both harvests is higher than 0.15 at 0.19% range reported by Soares et al. (2007) for white guavas; lower than 0.32 at 0.99% range of Singh and Pal (2008) who studied 'Lucknow-49', 'Allahabad Safeda' and 'Color Apple' guava cultivars in India.

Vitamin C fruit concentrations in the first harvest increased until it reached the calculated peak of 22.36

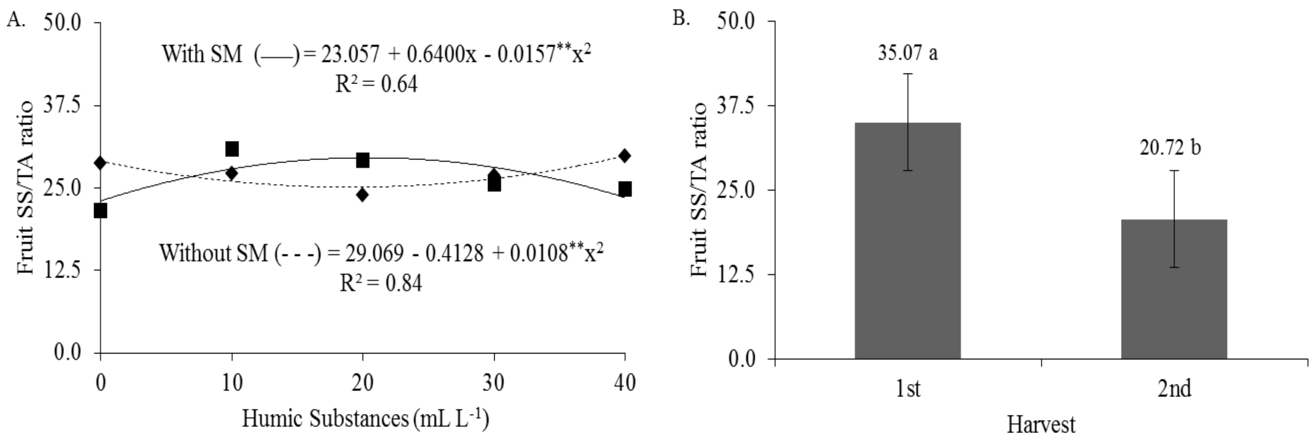

Figure 5. Fruit SS/TA ratio of guava as a function of humic substances and soil mulching (SM) (A) in two consecutive harvests (B).

mg 100 g^{-1}, recorded at 30.33 mL L^{-1} (Figure 4E). In the second harvest, vitamin C averages reduced to 14.4 mg 100 g^{-1}, with regards to 29.2 mL L^{-1}. These values are lower than 66.67 at 93.50 mg 100 g^{-1} range reported by Brackmann et al. (2012) for guava fruits cv. Paluma.

Average values of soluble solids/titratable acidity (SS/TA) ratio presented different data distribution as a function of soil mulching use (Figure 5A). For treatments without soil mulching, SS/TA ratio decreased to 25.12 at 19.1 mL L^{-1}, followed by a consecutive increasing with humic substances dose enhancement (Figure 5A). As shown in Figure 5B, average SS/TA ratio decreased from 35.07 in the first harvest to 20.72 in the second harvest, corresponding to a reduction of about 40.9%. The lower average shown in Figure 5B is higher than 26.04 presented by Ramos et al. (2011) for guava cv. Paluma. It is important to infer that SS/TA ratio is a characteristic for fruit sweetness evaluation due to the balance of acids and sugars, which is more representative than the measurement of these parameters alone. Therefore, when SS/TA ratio is high, it means that the fruit has a good taste and adequate maturation stage, as this ratio increases when there is a decrease in acidity and high content of soluble solids derived in maturity (Batista et al., 2013).

The reduction in SS/TA ratio from the first to the second harvest (Figure 5B) may have occurred due to rainfall and lower temperatures from April to July 2013. According to Souza et al. (2010), independent of maturation stage, rainfall reduces pH and SS/TA ratio as a function of more water content of fruits.

Conclusions

Humic substances enhance fruit production more efficiently in guava plants grown without soil mulching. Guava fruit production increases from the first to the second harvest. Fruit quality for titratable acidity, soluble solids, vitamin C and soluble solids/titratable acidity ratio is adequate independent of soil mulching use. Humic substances improve fruit quality of guava cv. Paluma. Under soil and climate conditions, and considering the first two production cycles of guava, it is possible to recommend about 20 mL L^{-1} of humic substances for production of high quality guava fruits.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES

Amorim DA, Rozane DE, Souza HA, Modesto VC, Natale W (2015a). Nitrogen and potassium fertilization in 'Paluma' guava trees: I. Effect on productivity and fruit quality for industrialization. Rev. Bras. Frutic. 37(1):201-209.

Amorim DA, Souza HA, Rozane DE, Montes RMM, Natale W (2015b). Nitrogen and potassium fertilization in 'Paluma' guava trees: II. Effect on nutritional status of the plants. Rev. Bras. Frutic. 37(1):210-219.

Bakshi P, Wali VK, Iqbal M, Jasrotia A, Kour K, Ahmed R, Bakshi M (2015). Sustainable fruit production by soil moisture conservation with different mulches: A review. Afr. J. Agric. Res. 10(52):4718-4729.

Batista AG, Oliveira BD, Oliveira MA, Guedes TJ, Silva DF, Pinto NAVD (2013). Quality parameters of frozen fruit pulp: an approach to a familiar agribusiness production of Jequitinhonha Upper Valley. Rev. Tecnol. Ciên. Agropec. 7(4):49-54.

Brackmann A, Anese RO, Both V, Thewes, FR, Fronza D (2012). Controlled atmosphere for storage of 'Paluma' guava. Rev. Ceres. 59(2):151-156.

Campos VB, Cavalcante LF, Dantas TAG, Mota JKM, Rodrigues AC, Diniz AA (2007). Physical and chemical characteristics of yellow passion fruits under fertilization potassium, bovine biofertilizer and mulch. Rev. Bras. Prod. Agroind. 9(1):59-71.

Ferreira TTS, Rodrigues DNB, Gomes Filho RR (2010). Coefficient of reduction of the evapotranspiration and demand hidric of fruit bowl in irrigated perimeter Jaguaribe – Ceará. Rev. Bras. Agric. Irr. 4(4):217-225.

Hojo RH, Chalfun NNJ, Hojo ETD, Veiga RD, Paglis CM, Lima LCO (2007). Production and quality of guava fruits 'Pedro Sato' submitted to different pruning times. Pesqui. Agropecu. Bras. 42(3):357-362.

Instituto Adolfo Lutz (2008). Physico-chemical methods for food analysis. 4th edition. São Paulo: Instituto Adolfo Lutz. P 1020.
IBGE - Instituto Brasileiro de Geografia e Estatística (2014). Permanent crops data. Available at: http://www.sidra.ibge.gov.br/bda/acervo/acervo9.asp?e=c&p=PA&z=t&o=11.
Mariano FAC, Bolioni AC, Corrêa LS, Moreira ER (2011). Sassaoka guava minimally processed and storage. Rev. Bras. Frutic. 1:384-391.
Natale W, Rozane DE, Prado RM, Romualdo LM, Souza HA, Hernandes A (2011). Economical dose of liming in yield of star fruit. Rev. Bras. Frutic. 33(4):1294-1299.
Natale W, Rozane DE, Souza HA, Amorim DA (2009). Guava cultivation from planting to commercialization. Jaboticabal: Unesp. P 289.
Ramos DP, Leonel S, Silva AC, Souza ME, Souza AP, Fragoso AM (2011). Pruning times in seasonality, yield and quality of 'Paluma' guava fruits. Semin. Ciênc. Agrár. 32(3):909-918.
Ramos DP, Silva AC, Leonel S, Costa SM, Damatto Júnior ER (2010). Yield and fruit quality of 'Paluma' guava pruned at different times in subtropical climate. Rev. Ceres. 57(5):659-664.
Rodrigues MS, Santana MC, Uchoa ALP, Menezes AXSM, Cavalcante IHL, Lima AMN (2015). Delineation of management zones based on soil physical attributes in an irrigated guava field in the Semi-Arid region, Brazil. Afr. J. Agric. Res. 10(45):4185-4192.
Sarkar S, Singh SR (2007). Interactive effect of tillage depth and mulch on soil temperature, productivity and water use pattern of rainfed barley (*Hordium vulgare* L.). Soil Tillage Res. 92(1-2):79-86.
Serrano LAL, Marinho CS, Ronchi CP, Lima IM, Martins MVV, Tardin FD (2007). 'Paluma' guava trees under different cultivation systems, times and intensities of fructification pruning. Pesqui. Agropecu. Bras. 42(6):785-792.
Silva GF, Cavalcante LF, Souza AP, Cavalcante IHL, Curvêlo CRS, Lima EM (2009). Growth and production of the guava cultivate 'Paluma' in response to nitrogen doses. Agropecu. Tec. 30(2):76-84.
Silva RAR, Nunes JC, Lima Neto AJ, Cavalcante LF, Silva MRM, Rodrigues RM (2013). Irrigation depths and soil cover in production and quality of soursop fruits. Rev. Bras. de Ciênc. Agrár. 8(3):441-447.
Silva RL, Cavalcante IHL, Sousa KSM, Galhardo CX, Santana EA, Lima DD (2015). Fruit quality of yellow passion fruit fertilized with nitrogen and humic substances. Com. Sci. 6(4):479-487.
Singh SP, Pal RK (2008). Controlled atmosphere storage of guava (*Psidium guajava* L.) fruit. Postharvest. Biol. Technol. 47(3):296-306.
Soares FD, Pereira T, Marques MOM, Monteiro AR (2007). Volatile and non-volatile chemical composition of the white guava fruit (*Psidium guajava*) at different stages of maturity. Food Chem. 100(1):15-21.
Souza HA, Rozane DE, Amorim DA, Modesto VC, Natale W (2014). Agronomic use of by-product of guava processing industry – II. nutritional status and production. Rev. Bras. Frutic. 36(3):725-730.
Souza ME, Silva AC, Souza AP, Tanaka AA, Leonel S (2010). Influence of the precipitations pluviometrics in physical-chemical attributes of the fruits of the guajava tree 'Paluma' in different stadiums of ripening. Rev. Bras. Frutic. 32(2):637-646.