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CONTENTS **Page No.**

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Variability and nutritive compounds of guava (*Psidium guajava* L.)

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ABSTRACT

Guava (*Psidium guajava* L.) is a tropical fruit plant. The study was conducted at three different altitudes in guava production center of Indonesia. The objectives of this research are to obtain information about the production and quality of guava at three locations by using manure applications. The study was conducted to guava plants at the age of 4 yr (first production). The study was designed according to the factorial design of 3 × 2 with 5 times replications. The first factor is the locations, which are the location-I (Pageruyung), location-II(Sukorejo) and location- III (Plantungan). The second factor is the provision of organic material of manure; without and with manure (2.5 t · ha^{-1}). The data collected is the guava production (total production for four months tree), diameter, weight, flesh thickness, seeds weight, fruit acid content and sugar content. Result of research showed (1.) the interaction between the location and the addition of manure in the cultivation of guava increased its fruit production, weight, and the sugar content, (2.) the research locations have elevation and soil chemical content varies in fruit diameter, seeds weight, and fruit acid content, (3.) manure significantly increased fruit production, weight, diameter, flesh thickness and sugar content, but it did not increase seeds weight and it reduced the fruit acid content.

Key words: Flesh thickness, Fruit acid content, Guava, Manure, Sugar content.

INTRODUCTION

Guava (*Psidium guajava* L.) is a tropical plant which can be grown in sub-tropical area with rainfall intensity ranges from 1000 to 2000 mm· year and evenly throughout the year. Guava is one of the species of tree fruit crops. This plant comes from the Brazilian Central America, which then spread to Thailand and to other Asian countries such as Indonesia. Until now, such plant has been cultivated and spread widely in the areas of Java (Indonesian Research and Technology Ministry, 2010) put as (Anonymous 2010). Its botanical nomenclature is *Psidium guajava* L. It belongs to botanical family of *Myrtaceae*. Its common name is Guava (widely used in Egypt, United States, Latin America, Asia, Africa), Guyaba (Cuba), Guayaba (Guatemala, Nicaragua, Paraguay), and Amrood (India). It is an important food crops and medicinal plants in the tropics and subtropics, which is widely used as food and medicine by the people all over the world (Guti'errez *et al.*, 2005). Guava has some beneficial biological activities namely ascorbic acid (Thaipong and Boonprakob, 2005), phenolics, flavonoids, carotenoids, terpenoids and saponins (Guti'errez *et al.*, 2005). Guava's main plant chemicals include ascorbic acid, ascorbigen, asiatic acid, aspartic acid, ellagic acid, gallic acid, glutamic acid, goreishic acid, guavacoumaric acid, guajivolic acid, guavenoic acid, guajavanoic acid, isoneriucoumaric acid, jacoumaric acid, linoleic acid, linolenic acid, myristic acid, oleanolic acid, oleic acid, oxalic acid, palmitic acid, palmitoleic acid, psidiolic acid (Joseph and Priya, 2011). Antioxidant potential of guava leaf showed the activity of free radicals as moderate antioxidant with IC50 values of 460.37 ± 1.33 mg · ml (Leea *et al.*, 2012). Strawberry Guava (*Psidium cattleianum*) is the superior one with the content of antioxidant, antimicrobial, phenolics and vitamin C (Ju-Wen *et al.*, 2009). Guava has relatively high fiber content (24.9 %). The results of guava extract, namely hexane and ethyl acetate, showed its anti-inflammatory (McCook-Russell *et al.*, 2012). Liming the guava orchard soil gives beneficial effects on guava quality, especially in its fresh taste and crunchy flesh and the shelf life of more than 8 days (Prado *et al.*, 2005).

Manure is an important source for crop production and soil sustainability. Manure is an important source of nutrients with high soil organic matter content, which capable of improving soil structure, and reducing vulnerability to water and wind erosion. One way to improve the soil quality and fertility in tropical and sub-tropical regions is the application of compost organic wastes such as manure (Eghball, 2002). The application of composted organic material slowly resulting in the release of large amounts of nitrogen and phosphorus, the increase of soil organic matter, root growth, seed germination rates, and the ability of soil to retain water (water holding capacity). The objective of this research is to obtain information about the production

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and quality of guava at three locations by using manure applications.

MATERIALS AND METHODS

Study Area : The study was conducted at three different altitudes in guava production centers, Kendal, Central Java, Indonesia, with its geographical position ranging from 109º 40' - 110º 18' East Longitude and 6º 32' - 7º 24' South Latitude.

Climate of the study area : The total rainfall in the study area is about 2 025 mm with an average of 135 d of rainy days. The rainy season starts from October to May (eight months) while the dry season starts from June to September. The altitude of research areas are 413 m above sea level (asl) in Location-I (Pageruyung), 524 m asl in Location -II (Sukorejo) and 698 m asl in Location-III (Plantungan). The temperature of the study area is 25-27º C, with humidity of 80-90%. The rainfall of the study area is 3556 and its average rainy days is 192. The rainfall data research areas are listed in Figure 1.

Based on Soil Research Centre (2005), Location-I has silty loam texture, acidic pH, medium org, medium KB, medium N, very low P and K. Location -II of Sukorejo has clay loam texture, slightly acid pH, medium C, high KB, high N, medium P, and low K. Location- III has silty loam texture, a slightly acid pH, medium C org, medium KB, low N, medium P and low K (Table 1).

Experimental Design: The study was conducted from September 2013 to November 2014. The study was conducted to guava plants at the age of four years (first production). The experiment was laid out in a factorial design with five replicates, with the location as the first factor and manure application as the second factor. The first factor is the locations, which are location-I (Pageruyung), location-II (Sukorejo) and location-III (Plantungan). The second factor is the provision of organic material of manure; without and with manure (2.5 t · ha^{-1}). The size of each block is 300 m^2. The spacing of guava plants is 4 × 5 m. The application of manure was conducted at the beginning of the rainy season (October) as much as 2.5 t · ha^{-1} (5 kg · $tree^{-1}$) by way of immersing it next to the guava tree. The manure nutrients itself is 1.2 % N, 0.5 % of P_2O_5, and K_2O of 0.34%. After the plants were flowering and began to form fruit, a reduction in ovary was done, into 3 pieces per stalk (February). The harvest of guava was conducted from June to October, with every harvest was recorded for its production.

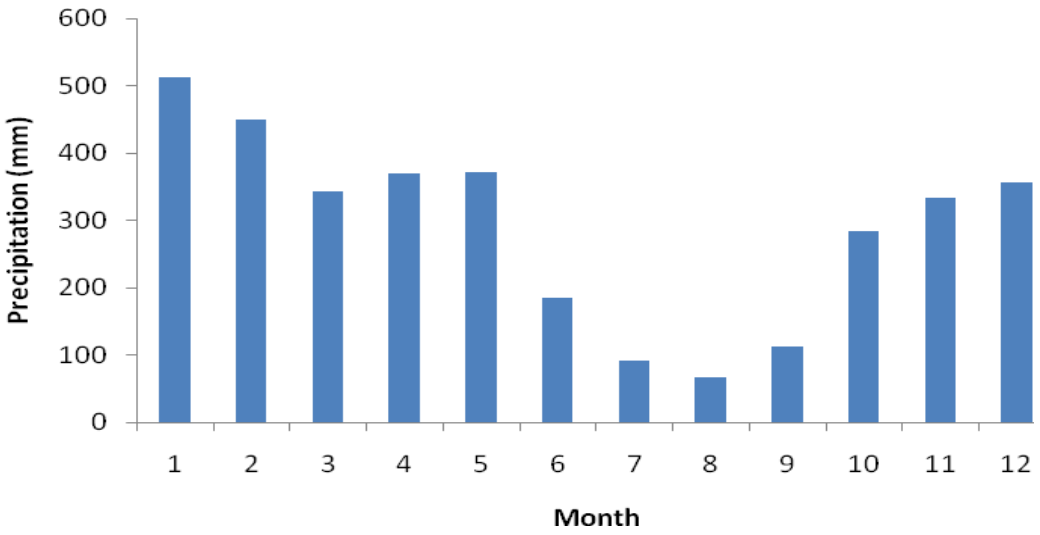

Fig 1: Rainfall pattern in the study areas

Table 1: Soil characteristics of the study areas

Location	I (413 m asl)	II (524 m asl)	III (698 m asl)
Texture	Light (silty loam)	Rather light (clay loam)	Light (silty loam)
pH H2O	5.8	6.2	6.0
C org (%)	3.2	2.7	3.0
Base saturation (%)	51	66	58
N (%)	0.4	0.6	0.2
P (HCl 25%, mg/100 g soil)	15	22	25
K (HCl 25%, mg/100 g soil)	8	11	15

Data collection: The data collected is the guava production (total production for four months), diameter, weight, flesh thickness, seeds weight, total fruit acid and sugar content (Brix). All data collected were then analyzed of variance and followed by DMRT (the Duncan's Multiple Range Test).

RESULTS AND DISCUSSION

The application of manure on guava plants in three different locations showed a significant effect on fruit weight and sugar content (Brix) of guava. The application of manure significantly affect on guava production, fruit weight, fruit diameter, flesh thickness, total fruit acid, sugar content, but it did not show significant effect on guava seeds. The location differences significantly affect the guava production, fruit weight and flesh thickness. However, the differences in location did not significantly affect in fruit diameter, seeds weight, total fruit acid and sugar content (Table 2).

Guava production, diameter and weight: Guava production is affected by manure provision. The highest production happened in location-II. The increase in production due to the provision of manure was 16.34 % to 30.84 %. The guava diameter increased due to the provision of manure as much as 27.71 % to 29.59 %. The weight of guava increased significantly with the addition of manure. Compared with no manure, guava weight increased from 44.93 up to 141.46 %. This increase was due to the presence of organic matter in manure that caused the soil to be better, provided additional nutrient elements, also increased nutrient uptake by guava plants (Table 2).

Flesh thickness: The flesh thickness of guava indicate the quality of it. Guava generated at location-I and location-III did not experience an increase in flesh thickness. While the flesh thickness of guava fruit at location-II increased significantly by 8.3 %. This means that the quality of guava on the site can still be improved by the provision of manure.

Guava seeds: The number of seeds in a guava fruit was also measured. Guava has a little seed compared to fruit weight with the ratio of 41.55 : 1.

Total fruit acid and sugar content : The results showed that the guava have much acid (average 8.46 %) and sugar content (average 6.85 %). The sugar content of guava due to the addition of manure increased from 9.85 % to 11.11%.

Giving manure significantly affects the guava production, weight, diameter, seeds, thickness, and sugar content. The similar result was also reported by Liu and Liu (2012), organic fertilizer addition promoted maturity. The weight per fruit was increased, and the contents of total soluble solids and sugars content were enhanced. Meanwhile, Zhao *et al*. (2014) reported the finding will be helpful for the harmonious development of apple production technology, economic income increase for farmers, and improvement of the apple orchard ecosystem.

Manure adds the nutrient adequacy requirements and improves soil physical properties and the ability to hold water (the water holding capacity). Organic fertilizer (manure) provides residual effect on the growth and yield which is improving environmental conditions as well as reducing the cost of purchasing an artificial fertilizer. Such effect is a good reason to use organic materials. Organic fertilizers improve soil fertility by activating the microbial biomass. The application of manure encourages the soil to do cycling of nutrients better. Manure is applied to supply N for excess soil P, and crop production requires an adequate amount of nutrients. Soil with decreasing content of nitrogen requires additional N to produce forage production (Jungnitsch *et al*., 2011). Manure supplies all kinds of macro

Table 2: The Duncan test on guava production, fruit weight, diameter, seeds weight, flesh thickness, total fruit acid, and sugar content due to the provision of manure at three different locations.

Treatment	Production (kg · tree–1 yr–1)	Fruit weight (g)	Diameter (cm)	Seeds weight(g)	Flesh thickness (cm)	Total fruit acid (%)	Sugar content /Brix(%)
Location- I (413 m asl)							
No manure	69.40	123.00cd	18.52	4.20	1.10	10.20	6.48b
Manure	90.80	297.00a	24.00	4.50	1.40	8.00	7.20a
Location-II (524 m asl)							
No manure	64.00	111.60d	18.52	3.30	1.12	10.60	6.50b
Manure	79.20	195.60b	22.80	4.30	1.20	6.60	7.14a
Location-III (698 m asl)							
No manure	62.40	120.20cd	16.60	4.00	1.12	8.60	6.98ab
Manure	72.60	174.20bc	21.20	3.90	1.22	6.80	6.80ab
Location-I	67.50b	147.20b	18.9	3.95	1.17b	7.70	6.89
Location-II	80.10a	210.00a	19.7	4.35	1.28a	9.10	6.84
Location-III	71.60b	153.60b	20.6	3.80	1.16b	8.60	6.82
No manure	66.27b	118.27b	16.84b	3.83	1.13b	9.80a	6.64b
Manure	80.87a	222.27a	22.66a	4.23	1.27a	7.12b	7.05a

Description: The numbers followed by different letters indicate significant differences (P <0.05)

and micro nutrients required by the plants in the available form, thereby it can improve the physical and biological properties of soil. Fertilizer is usually applied at a higher level, compared with inorganic fertilizer (Gulshan *et al.*, 2013). The rest of the plants should be embedded into the ground so that the nutrients will not be dissolved and pollute rivers and water bodies (Newton *et al.*, 2003). The proper use of manure for crop production can conserve the biological diversity of microbes in the topsoil and allow nutrients plants capable of producing forage (Annicchiarico *et al.*, 2011). The application of chicken manure at 60 t ‡ ha^{-1} increased the number of leaves, leaf area, fresh weight and dry weight of leaf lettuce (Masarirambi *et al.*, 2012). The average yield of barley was higher due to the addition of dry manure. Plants show signs of N deficiency by yellowing the entire leaf at the bottom of the plant (Benke *et al.*, 2010). Proper use of manure for crop production can conserve biological diversity of microbes in the topsoil and allow nutrients plants to be able to produce forage (Annicchiarico *et al.*, 2011).

In line with this study, the interaction between locations and manure have a significant effect on guava fruit weight and sugar content, with the highest fruit weight at the first location (413 m asl), while the sugar content had the same effect on the three study areas by applying manure. The application of 2.5 t · ha^{-1} manure which was equivalent to 37.5 % of nitrogen could increase guava production per tree, its weight, diameter, flesh thickness, and sugar content, whereas seeds weight gave the same effect and decreased the total fruit acid. This indicated a better quality guava by simply adding as much as 2500 kg manure per year at the time the plants would form a flower. The achievement of the highest value for guava weight and its sugar content was an important goal of our research. The use of manure 2.5 t · ha^{-1} as organic fertilizer could be done to reach the maximum production to 80.87 kg · tree^{-1}· yr^{-1}. The average guava production in the addition of manure gave the best results. The average guava production in the addition of manure gives the best results. Overall, guava cultivation without the addition of manure gave lower significant results than those with the addition of manure. This low result could be explained by the fact that the number of flowers produced was fewer and the fruit was smaller in size. Judging from the amount of rainfall, the study areas have the same rainfall because of their adjacent locations. The location-I, with somewhat silty loam texture conditions as well as pH 5.8, C organic 3.2 % and 0.4 % content of nitrogen, indicates that its soil condition was fertile, therefore, it affected the production of fruit, fruit weight and flesh thickness to be higher than the two other locations.

CONCLUSIONS

1. The interaction between the location and the addition of manure in the cultivation of guava increases its fruit weight, and the sugar content.
2. The research locations have elevation and soil chemical content varies in fruit diameter, seeds weight, and total fruit acid content.
3. Manure significantly increased fruit production, fruit weight, fruit diameter, flesh thickness, and sugar content, but it did not increase seeds weight and it reduced the total fruit acid content.

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