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Influence of Microorganisms and Nitrogen forms on Performance of Guava Trees Grown in Calcareous Soil

[1]El-Shamma, M. S., [1]Omaima, M. Hafez, [1]Maksoud, M. A. Nagwa, [1]S. Zaied and [2]El-habbaa, G. M.

[1]Pomology Research Dept., National Research Centre, 33 El-Dokki, Bohouth St., Egypt. Postal Code: 12622.
[2]Phytopath Dept., Faculty Agric. Benha University, Egypt.

ABSTRACT

In calcareous soil at El-Saff district-Giza Governorate, the Effects of two different nitrogen forms and /or three fungal bio-fertilizer levels on growth, leaf mineral contents, yield and fruit quality of Egyptian Balady Guava were compared with N in urea form. The experiment was arranged in a completely randomized design consisting of 3x3 factorial combinations of three bio-fertilizer levels (0, 10 and 20 ml.) and three nitrogen forms (urea; urea formaldehyde and Sulfur-coated urea). The results for either fungal bio-fertilization at low level and/or N in urea form have shown no significant increase in both growth and fruit quality for treated trees. However, application of N in slow release form *i.e.*, Sulfur coated urea or urea formaldehyde were favorable in improving fungal colonization Percentages besides tree performance compared with N in urea form. Where, Sulfur coated urea treatment was more effective in this respect. Furthermore, trees bio-fertilized with fungi at low or high level, equally recorded best values for vegetative growth, macro- and micro-nutrient contents besides its superiority in improving yield and fruit quality as treated with N in sulfur-coated form. Also, it is noticed that urea formaldehyde treatment arranged the next order as applied to bio-fertilized trees, mainly high level**.** Nitrogen in urea form significantly produced pronounced values for both growth and fruit parameters as added to trees inoculated with high fungal level. The results of our study led us to conclude that application of Sulfur coated urea to guava trees bio-fertilized with vascular Arbascular fungi at either 10 or 20 ml. level improved its growth performance, yield and fruit quality under calcareous soil conditions.

Key words: Guava trees, N fertilizer forms, bio-fertilizer fungi, Fruit quality, Yield.

Introduction

Guava (*Psidium guajava* L.) proved to be one of the most important fruits grown in both old valley and new reclaimed area, where around 20–30% of soils under Guava are calcareous with pH above 7.5. Also, high excessive irrigation provides favorable conditions for nutrient through leaching and/or volatilization in production system (Paramasivam *et al*., 2001 and He *et al*., 2002).

Nitrogen is known to be essential nutrient for plant development because of its role in proteins, nucleic acids and enzymes synthesis (Marschner, 1995). If applied as urea or NH^{+4} undergoes chemical transformation to produce either ammonia (NH_3) or nitrate (NO^{-3}), depending on soil pH, application methods and moisture conditions. Ammonia volatilization may contribute substantially to N loss in Calcareous sandy soils that cover a large proportion of newly reclaimed soils, where previous study showed that 150–240 kg^{-1} of the applied N could be lost by volatilization in fine sand (pH 7.9) depending on fertilizer sources (He *et al*., 2002). Furthermore, extensive studies were conducted to quantify N leaching loss in Calcareous soils because of public concern that nitrate is not absorbed by the tree root system can be leached below the root zone and results in contamination of the groundwater (Diez *et al*., 1994 and Paramasivam *et al*., 2001). Also, Kithome *et al*. (1998) reported that ammonium retained in soil by subjecting to slow release cation exchange and nitrification. Where, the efficiency of slow release nitrogen forms can potentially reduce nitrogen losses, improve the efficiency of plant recovery and decrease soil pH due to the acidic effect of urea-formaldehyde or sulfur coated urea. It is well known that lowing soil pH improves the availability of many nutrients needed for growing plants (Diez *et al.,* 1994). So, it is of important to improve efficiency of nitrogen fertilizer as added in calcareous soils by introducing alternative techniques (Ciprian and Iovu, 2010). Out of those, Eman *et al*., 2009 and Abdou *et al*., 2011 reported that application of controlled release N fertilizers *i.e.* urea formaldehyde form improved efficiency of nitrogen fertilizer as added in calcareous soils by reducing the replication additive number, minimize production cost, reducing N leaching and controlling nitrate pollution. Also, sulfur-coated urea that contains nearly 40% N besides 15-20% Sulfur is usually used to promote rhizosphere activity, reduce soil pH

Corresponding Author: Mahmoud El-Shamma, Pomology Res. Dept., National Research Centre, Dokki, Egypt. Postal Code.12622.
E-mail: mahmoud_elshamma@yahoo.com

and subsequently increases the availability of soil nutrients (Boutros *et al.,* 1995). Similarly, considerable attention has been attracted to the possibilities of using bio-fertilizers *i.e.,* Mycorrhizae fungi as agro-technical factor for increasing nutrients uptake in fruit orchards. The principal function of these associations is enhancing the solubility of different nutrients and the efficiency of its absorption (Nelson and Achar and Bâ *et al*., 2001). They also reported that these microorganisms proved to be more effective in correcting nutrient deficiencies and maintaining proper metal balance in plant tissues. Trees treated with fungal bio-fertilizers accumulate more K, Ca, Cu and Mn in plant leaf (Huiying, 2005 and Fernando *et al*., 2010). VAM fungi interact with other soil microbes like free-living nitrogen fixers to improve their efficiency for the biochemical cycling of elements to the plants (Linderman, 1988). However, there is relatively limited information concerning performance of Guava trees bio-fertilized with VAM Fungi under sandy Calcareous soil conditions.

Therefore, our study was performed to improve the efficiency of N by evaluate other nitrogen forms with alternative techniques and/or VA Mycorrhizae inoculations to reduce NH_3 volatilization and maximize N uptake efficiency in Guava orchards cultivated in calcareous soils.

Materials and Methods

This study was carried out through two seasons 2013 and 2014 on 8 years old Balady Guava trees *(P. guajava* L) grown at 5x5 meters a part under drip irrigation system. Selected trees were cultivated in a private orchard located at El-Saff District - Giza Governorate. All trees were almost uniform in vigor, grown in a soil classified as sandy calcareous under conventionally accepted practices with fertilizing rate: 300g N, 160g P_2O_5 and 150g K_2O/tree. Soil properties were Sand 79.4%, Silt 14.5%, Clay 6.1%, Organic Matter 0.8 %, total $CaCO_3$ *7.1 %,* pH 8.6 and available microelements N 0.09, P 3.25, K 19.2 and Ca 21.7 ppm.

Two weeks after manure addition, trees were bio-fertilized with VA Mycorrhizal fungi (VAM) spores at 3 levels (0, 10 and 20 ml. of spore suspension/tree) expressed as VAM (0, I and II), respectively - each ml. contains 50 spores. Spore suspension was prepared by Wet- Sieving and Decanting procedure (Gerdmann and Nicolson, 1963), diluted to reach 10 ml. and boarded throughout root growth area. Tested fertilizer forms were used as N source to obtain actual N at 300g/tree, resembling urea (46.5% N) or urea formaldehyde (38.4% N) or sulfur-coated urea (40% N). Urea formaldehyde or sulfur- coated urea were applied once as spring start, while the fast release one (urea) was added as spring growth start and after fruit set. Each N form was examined in trees inoculated with the three VAM levels that received the basal P and K fertilizer rates. Treatments were arranged in complete randomized block design with three replicates each represented by two trees.

The effects of VAM inoculation levels and / or nitrogen forms were determined as follows:

VAM infection %:

Root samples were digged, cleared, stained with lactophenol cotton blue and spores were counted as described by Gerdmann and Nicolson, (1963).

Vegetative parameters:

Number of shoots / branch and Shoot length:

At first of April, four branches uniform in diameter and length, distributed on tree directions were labeled. Number of developing shoots per branch counted and tagged to determine shoot length as growth ceased at mid-December.

Leaf Area

In mid-September, samples of twenty leaves (the third leaf from the base of the tagged non-fruiting shoots) were collected and leaf area was determined using Planimeter.

Leaf total chlorophyll contents was determined according to Wettstein, (1957).
Leaf Total Carbohydrates was determined according to Smith *et al*. (1986).
Leaf dry Weight: leaves were washed, oven dried at 70°C till a constant weight, then leaf dry weight (mg) was determined.

Leaf chemical contents

Nutrient contents**:** N, P, K, Mg% and Fe, Zn, Mn /ppm were determined according to Rebbeca, (2004).

Fruit physical characters:

Fruit weight (g), No. / kg, length cm (L), diameter cm (D), volume (ml.), Flesh thickness(mm) and Yield kg/tree were measured, where fruit shape calculated as L/D ratio.

Fruit chemical contents

In fruit juice, soluble solid contents % was determined using hand refractometer, total acidity % was determined as citric acid, and S.S.C/ acidity % was calculated, Vitamin C (mg/ 100g Fresh Weight.) was also determined by titration with 2-6 Dichlorophenol – Indophenol and total sugar contents were estimated according to (A.O.A.C, 1985).

Calcium concentration in leaves and fruits was extracted by nitric–perchloric acid, digested and determined using atom absorption spectrometry (Bataglia *et al.,* 1983).

Statistical analysis:

Obtained data were subjected to analysis of variance according to the procedure reported by Snedecor and Cochran, 1989. Means were compared by L.S.D test at 5% level of probability.

Results and Discussion

Infection percentages and growth parameters:

VA Mycorrhizal infection%:

Data in Table 1 indicate that infection% of Mycorrhizal trees was positively increased by inoculation levels. The fast release urea (U) reflected nearly double folds as added to the highest VAM inoculation rate, comparing with un-inoculated control. Also, slow release N forms increased infection% to reach three folds with sulfur coated urea (SCU) as combined with either low or high inoculation level (51.5 and 52.2%), respectively. While, high infection percentage (45.4%) significantly obtained with high inoculation level in trees fertilized with the slow release urea Formaldehyde (UF). These results are in harmony with Fernando *et al*., (2010) who mentioned to the role played by AM symbiosis in such soils and provide guidance on the most appropriate alternatives to increase its presence and functionality. Also, Boutros *et al*., (1995) and Bâ *et al.*, (2001) reported that sulfur amendment increases root penetration depth, improve soil properties and possibly soil aeration, as well as promoting rhizosphere activity in sandy soil.

Growth parameters:

Number of shoots/ branch, Shoot length and leaf area were taken as indicators for tree growth (Table 1). Growth of trees inoculated with high VAM level was increased as treated with different N fertilizer forms compared to the un inoculated U control. Moreover, trees fertilized with SCU at both inoculation level, proved to be the superior treatments in enhancing shoot length (49.9&50.1cm.), number of shoots per branch (6.2&6.3) and growth of leaf area (34.8&35.1 cm^2) with similar positive effect, followed in descending order by trees inoculated with high VAM level and fertilized with U.F. than those treated with low VAM level + U.F. fertilizer.

Leaf Total Chlorophyll Content:

Table 1 show that different tested N forms induced a pronounced positive effect on leaf total chlorophyll content of inoculated trees as compared with un-inoculated U control. In this respect, Trees inoculated with either high or low VAM level and treated with S.C.U predominated in enhancing chlorophyll synthesis (5.3&5.2 mg/*L*) followed in descending order by trees treated with VAM at high level + U.F.(4.7 mg */L*). Moreover, application of U either alone or combined with low VAM level, induced the lowest positive values followed in ascending order by U+ VAM at high level.

Leaf Dry Weight

Recorded data show that trees fertilized with either slow release N form produced higher leaf dry weight compared with the analogous ones fertilized with the traditional fast release N fertilizer "control". Moreover, the tested treatments surpassed SCU as combined with either VAM levels in producing highest leaf dry weight values (919& 917 mg), with non-significant differences. However, applying UF to trees inoculated with high VAM level revealed positive response (910 mg), in this respect. Contrarily, least Dry Weight values were significantly obtained with U treatment, either alone or in combination with lower VAM level.

Leaf Total Carbohydrates (%):

Tabulated data reveal that different N forms surpassed the fast release nitrogen fertilizer "control", especially with trees inoculated at high level. Generally, the higher values of total carbohydrates (20.3 &20.1%) were significantly obtained as SCU treatment combined with high or low inoculation level, respectively. Moreover, UF treatment reflected high Carbohydrate values in trees inoculated with high VAM level (19.5%). Other treatments took an intermediate position in this concern. The importance of nitrogen as essential constituent of chlorophyll, protoplasm, proteins and nucleic acid for increasing growth parameters, was discussed by (Wassel and Ebrahiem, 2000 and Mario and Lucia, 2008), Where, the improving effect of SCU and UF on vegetative growth might be attributed to their low activity index that regulating the N release according to plant need, compared with fast release one (urea) which gave the lowest values of available N left in the soil (Paramasivam and Sajwan, 2001 and Mario and Lucia, 2008). In addition, the dominance in growth parameters due to acidification of SCU treatment resulted from Sulfur oxidation that decreased soil pH and enhanced nutrients solubility besides increasing the activity of micro-organisms, (El-Tarabily *et al.,* 2006 and Abdou *et al*., 2011).

Concerning VAM effects, the increment in growth of inoculated trees may be due to the ability of inoculated fungi to produce growth promoting substances, organic & inorganic acids and CO_2 which lead to increase in soil acidity and consequently convert the insoluble forms of nutrients into soluble ones (Nelson and Achar, 2001 and Tabassum *et al.,* 2012). The fungal hyphae also help in retaining moisture around plant root zone (Bâ *et al*., and Morte *et al*., 2001) which lead to efficient mobilization and uptake of nutrients. Tabassum *et al*., 2012 reported that VAM fungi interact with other soil microbes like free-living nitrogen fixers and phosphate solubilizers to improve their efficiency for the biochemical cycling of elements to the host plants. This may explain why the highest growth values were detected in trees inoculated with VAM fungi.

Table 1: Effect of VAM inoculation and / or N sources on infection % and Growth of Guava trees under calcareous soil conditions (Mean of 2 seasons).

N source	VAM level	VAM infection %	No. of Shoots/ branch	Shoot length (cm)	Chlorophyll (mg/L)	leaf dry weight (mg)	Total Carbo-hydrates %	leaf area Cm^2
U	0	17.4 f	4.4 f	42.4 f	2.1 ef	870 f	15.4 gh	29.2 g
	I	22.1 e	4.6 ef	43.3 f	2.5 e	876 f	16.0 g	29.9 fg
	II	36.0 c	5.4 c	46.4 d	3.9 c	895 d	18.1 d	32.8 cd
SCU	0	31.4 d	5.1 d	45.3 e	3.4 d	889 de	17.4 e	31.4 e
	I	51.5 a	6.2 a	49.9 a	5.2 a	917 a	20.1 a	34.8 a
	II	52.2 a	6.3 a	50.1 a	5.3 a	919 a	20.3 a	35.1 a
UF	0	26.7 e	4.9 de	44.5 e	3.0 d	883 e	16.7 f	30.7 ef
	I	40.8 b	5.7 b	47.5 c	4.3 bc	903 c	18.8 c	33.5 c
	II	45.4 ab	5.9 ab	48.7 b	4.7 b	910 b	19.5 ab	34.3 ab

**U: Urea (46.5% N); U.F.: Urea formaldehyde (38.37% N) ; S.C.U.: Sulfur-coated urea. (40 %N)*
** In columns followed by the same letter are not sign. different Means according to L.S.D. test (P = 0.05).*

Leaf chemical contents

Macro nutrient contents %:

Nitrogen:

The sole application of different N forms including control succeeded in enhancing leaf nitrogen content up to the optimum range according to current guide lines. Adding either tested N forms to inoculated trees induced statistically similar and higher positive effect. In this respect, SCU+ low or high VAM level dominated in increasing nitrogen content (2.04 & 2.02 %), respectively against (1.74 & 1.93%) for control treatment. Moreover, UF+ high VAM level exerted comparatively high enhancing effect on leaf nitrogen content (2.10%).

Phosphorus:

Tabulated data declare that all tested treatments enhanced leaf phosphorus content in comparison with the un-inoculated control. Generally, inoculated trees at high level scored higher leaf phosphorus contents (0.212 & 0.199 and 0.181%) for SCU, UF and U forms, respectively. In addition, P content was within the high range in trees treated with VAM at low level + SCU fertilizer

Potassium:

Table (2) demonstrates that both slow release nitrogen fertilizers surpassed the fast one for increasing leaf K values. SCU treatment scored the highest significant Potassium values (1.81&1.79%) as combined with VAM at low or high level, respectively. Moreover, combined effect of high VAM level + UF produced similar high values (1.78%) with non significant differences.

Calcium:

Data illustrate that SCU + VAM treatments at both levels recorded the highest leaf calcium values (1.55&1.53%). Similarly, UF +VAM treatments at either level scored the second order, in this respect (1.49 and 1.46%). Furthermore, U treatment produced the lowest significant effects as applied alone (1.28%) and enhanced as combined with low VAM inoculation rate to reach (1.42%).

Magnesium

It is evident from obtained data that N application in slow release forms was significantly preferable in increasing leaf Magnesium percentages than those treated with the fast release one. Moreover, treatments of SCU+ VAM at either level exerted similar trend that obtained for Calcium percentages(0.384 and 0.379%)

followed in descending order by UF with comparatively higher enhancing effect as combined with either VAM inoculated levels (0.336 and 0.351%).

Micro-nutrient contents ppm

Data presented in Table 2 show that different treatments resulted in improving leaf Fe, Zn and Mn status within the optimum range according to current guide lines, except those treated with U form either alone or as combined with low VAM level. The vice versa was significantly obtained in trees inoculated with VAM at high or low level and fertilized with SCU that exhibited highest values of leaf Fe, Zn and Mn contents. In this respect, UF fertilizer scored the second order as combined with VAM treatment at high level. The rest treatments produced lower positive effect for tested micro-nutrients.

The above mentioned results revealed that adding nitrogen fertilizers in slow release form alone or combined with VAM inoculation actively transported macro and micro-nutrients up to the trees reflecting remarkable increment in mineral contents to be within or higher than the optimum guide lines range. In general, the higher followed by lower VAM inoculation levels showed best results as combined with SCU fertilizer, followed in descending order by UF fertilizer + high VAM level.

Results concerning effect of slow release N fertilizer are in agree with those obtained by Eman *et al.* (2009) and Ciprian and Iovu, (2010). In addition, the observed benefits of Sulfur application may be attributed to the increased availability of nutrients in trees fertilized with SCU (El-Tarabily *et al.*, 2006 and Ciprian and Iovu, 2010). The increment in nutrient absorption by Mycorrhizal trees were in agreement with the findings of Huiying, 2005, Fernando *et al.*, 2010 and Almagrabi and Abdelmoneim, 2012. They reported that raising fungal inoculation level induced a remarkable and pronounced effect on leaf mineral content than those of sole fast release N fertilizers.

Table 2: Effect of VAM inoculation and / or nitrogen sources on leaf chemical contents of Guava trees grown in calcareous soil. (Mean of 2 seasons).

N Form	level	Macro nutrient contents %					Micro nutrient %		
		N	P	K	Ca	Mg	Fe	Zn	Mn
U	0	1.70 h	0.140h	1.44 g	1.28 e	0.246 e	36.1 h	22.6 g	20.3 g
	I	1.74 g	0.149g	1.49 f	1.31 e	0.264 d	38.4 g	23.9 g	22.4 g
	II	1.93 d	0.181d	1.68 c	1.42 c	0.317 c	45.3 d	28.6 d	29.5 d
SCU	0	1.86 e	0.170e	1.62 d	1.39 c	0.296 d	43.0 e	26.9 e	27.1 e
	I	2.02 a	0.209a	1.79 a	1.53 a	0.379 a	53.4 a	32.6 a	36.8 a
	II	2.04 a	0.212a	1.81 a	1.55 a	0.384 a	54.8 a	33.2 a	37.4 a
UF	0	1.80 f	0.159f	1.55 e	1.35 d	0.275 d	40.7 f	25.3 f	24.7 f
	I	1.98 c	0.190c	1.74 b	1.46 b	0.336 b	47.7 c	30.4 c	31.9 c
	II	2.10 b	0.199b	1.78 a	1.49 b	0.351 b	50.1 b	31.9 b	34.1 b

**U: Urea (46.5% N); UF: Urea formaldehyde (38.37% N); S.C.U.: Sulfur-coated urea. (40 % N)*
**Means in column followed by the same letters are not sign. different according to L.S.D. (P = 0.05).*

Fruit Physical characteristics:

Fruit weight:

Table (3) show that tested treatments increased fruit weight as compared with un- inoculated control. In this respect, SCU treatment produced statistically similar and highest positive effect on fruit weight of trees inoculated with high or low VAM level (166.1&165.8 *g*), as compared with the rest tested treatments. Additionally, trees inoculated with high VAM level and fertilized with UF arranged in the third order.

Fruit numbers / Kg:

Data also showed that fruit numbers/ kg were negatively affected by slow release nitrogen fertilizer applications rather than urea. The reduction effect was mainly associated by increasing in fruit weight. SCU treatment proved to be the most efficient treatment in reducing fruit number/kg, especially as combined with either VAM level (6.03&6.02) with non significant differences. Moreover, U treatment increased fruit number to reflect high significant values (9.30) and arranged the first, in this respect.

Fruit shape index (L/D)

It is obvious from Table (3) that tested nitrogen forms produced a pronounced positive effect on either fruit length (L) or Fruit Diameter (D) as compared with the un-inoculated U control. According to the parallel increment in both fruit length (L) or Fruit Diameter (D), consequently Fruit shape index (L/D) ratios were attained in non-significant differences for tested treatments.

Fruit volume

Tabulated data demonstrated that slow release fertilizers succeeded in enhancing fruit volume as compared with the traditional fast release nitrogen "control". The highest effect was significantly obtained as VAM at either level was treated with SCU (114&112 ml.). The efficiency of UF fertilizer exerted statistically higher effect as combined with high VAM level (108 ml.). Moreover, applying urea to low Mycorrhizal trees failed to reflect any significant increase in this respect.

Flesh thickness:

Regardless effect of urea or U + low VAM level, data cleared a significant increase in flesh thickness by different treatments. Maximum values were obtained in trees inoculated with low or high VAM rate and fertilized with SCU (14.3&14.5 *mm*.) followed by UF fertilizer + high VAM rate (13.8 *mm*.). In this respect, UF + low VAM level surpassed the other tested treatments.

Total Yield /tree:

As shown in (Table 3), fertilization of guava trees with SCU or UF fertilizers significantly increased fruit weight, fruit number/tree and consequently tree yield than those of quick release nitrogen fertilizer (control). The highest yield values were recorded with sole treatment of SCU (69.2 *Kg*) followed by UF treatments (63.6 *Kg*). Inoculation treatment succeeded in improving fruit physical characteristics as fertilized with SCU followed in descending order by UF treatment. The quick release nitrogen fertilizer "control" induced remarkable effect as added to high Mycorrhizal level.

In general, increasing inoculation level via either fast or slow release fertilizers resulted in increased yield components. While application of SCU fertilizers to low or high Mycorrhizal trees recorded the highest yield values (87.8 or 89.5 *Kg* per tree) with non significant differences. In descending order, high or low VAM levels produced higher yield values as fertilized with UF (83.9 kg & 79.0 kg.), respectively. Though the high inoculation rate was responsible for enhancing urea effect to reach (73.9 Kg), lower yield values were statistically obtained as U added to low inoculated trees (58.3 Kg). The remained treatments gave in between values in this respect.

Table 3: Effect of VAM inoculation and / or nitrogen sources on fruit physical characters of Balady Guava tree grown in calcareous soils. (Mean of 2 seasons).

N Form	VAM level	Fruit Wt. (g)	Fruit No. per each (kg)	Fruit length (L) cm	Fruit Diameter (D)	Fruit shape L/D	Fruit volume (ml.)	Flesh thickness (mm)	Yield kg/tree
U	0	107.5gh	9.30 a	7.66 gh	6.52gh	1.18	88 g	10.3 g	53.4 g
	I	115.1 g	8.69 b	7.76 g	6.58 g	1.18	92 f	10.8 g	58.3 f
	II	136.1d	7.35 d	8.09 d	6.79 d	1.19	101 d	12.5 d	73.9 d
SCU	0	130.3e	7.68 d	7.98 e	6.73 de	1.19	97 e	12.0 de	69.2 e
	I	165.8 a	6.03 g	8.44 a	7.00 a	1.21	112 a	14.3 a	87.8 a
	II	166.1 a	6.02 g	8.46 a	7.02 a	1.21	114 a	14.5 a	89.5 a
UF	0	125.5 f	7.97 c	7.87 f	6.65 f	1.18	94 ef	11.4 f	63.6 e
	I	157.2 c	6.36 e	8.21 c	6.86 c	1.20	105 bc	13.2 c	79.0 c
	II	161.0 b	6.21 f	8.32 b	6.95 b	1.20	108 b	13.8 b	83.9 b

U: Urea (46.5% N); UF: Urea formaldehyde (38.37% N); S.C.U.: Sulfur - coated urea.(40 % N)
Means in column followed by the same letter are not sign. different according to L.S.D. test (P = 0.05)

Fruit chemical contents:

Total Soluble Solids Percentage (SSC%):

Data in Table 4 cleared that applying SCU or UF fertilizers, equally improved fruit SSC contents compared to control. The highest SSC values were found as high or low Mycorrhizal trees fertilized with SCU (11.60 or 11.52%, respectively) followed in descending order by UF as combined with either high or low VAM level(11.14 or 10.76%) with significant differences. On the other hand, the remained treatments scored in between values in this concern.

Total acidity (%) :

Results proved that all tested treatments succeeded in reducing total acid content in comparison with the sole urea treatment. Maximum reduction values were equally obtained with non significant differences (0.87%) either SCU applied to high or low inoculated trees or UF fertilized applied to high inoculated trees (0.88%). Also, reduction effects were recorded in similar with those of sole SCU or UF applications (0.93). Where, urea treatment recorded the highest, in this respect.

S.S.C/Acid Ratio:

It is obvious from data that Mycorrhizal trees at low or high level produced fruits with highest S.S.C/acid ratios as fertilized with N in SCU form (13.33&13.24), compared with other used treatments or U control. While, UF+ either VAM levels followed in descending order by urea + high VAM level recorded higher significant values, in this respect.

Total Sugars (%):

Data cleared that both slow release fertilizers forms produced fruits rich in their total sugar contents than those produced by urea fertilizer. The higher values were recorded in inoculated trees at both levels and fertilized by SCU to be the best in this concern (11.6 and 11.4%). Moreover, UF exerted higher effect on fruit sugars as applied to trees with high VAM level (10.9%) followed by UF + low VAM level (10.3%).While, urea improved sugar contents as combined with high VAM level (9.7%).

Vitamin C content:

Tabulated data revealed that SCU or UF fertilizers enhanced fruit citric acid content comparing with control. Best s results were similarly obtained by using SCU with either Mycorrhizal level (94.8 & 92.7 mg). Furthermore, V.C. content was significantly enhanced in trees treated with high VAM level and fertilized by N in UF form (91.2 mg).Also, high VAM level proved to be essential for enhancing urea fertilizer to produce pronounced values of V.C.

Fruit Calcium content:

Table 4 shows that all tested treatments succeeded in increasing fruit calcium content in comparison with un-inoculated control. Applying SCU or UF to inoculated trees proved to be the best treatments. Where, SCU induced the highest effect as added to either Mycorrhizal levels, followed in descending order by UF+ high VAM level and UF+ low VAM level. Meanwhile, urea treatment increased fruit Ca content to higher values as combined with high VAM level. The rest treatments scored in between values in this respect.

On the basis of obtained results, it may be concluded that inoculation of guava trees with high VAM rate improved tree growth, increased leaf mineral contents and fruit yield of high quality. These observations were markedly pronounced in trees dual fertilized with VAM + SCU.

The prospective results for slow release N fertilizers on fruit properties, yield and fruit quality are in harmony with the findings of He *et al.* (2002), El-Tarabily *et al.* (2006) and Abdou *et al.* (2011). Such observation may be due to the ability of VAM fungi to interact with other soil microbes like the free-living nitrogen fixers and phosphate solubilizers to improve their efficiency for the biochemical cycling of elements and supply the host trees with their nutrients requirements (Morte *et al.*, 2001; Huiying, 2005; Fernando *et al.*, 2010 and Almagrabi and Abdelmoneim, 2012).

Table 4: Effect of VAM inoculation and / or nitrogen sources on fruit chemical contents of Guava trees grown in calcareous soil. (Mean of 2 seasons).

N forms	VAM level	SSC (%)	Total acidity (%)	SSC/acid	Total sugars (%)	Vitamin C mg/100g F.Wt.)	Ca (mg/100g Dry Wt.)
U	0	8.57 g	0.98 d	8.75 h	7.2 h	68.9 f	8.12 h
	I	9.14 f	0.95c	9.62 f	7.8 g	72.1 f	8.88 g
	II	10.38 d	0.93b	11.16 d	9.7 d	82.8 d	11.00 a
SCU	0	10.00e	0.93b	10.75 e	9.1 e	80.2 d	10.34 e
	I	11.52a	0.87a	13.24 a	11.4 a	92.7 a	13.58 a
	II	11.60 a	0.87 a	13.33 a	11.6 a	94.8 a	13.82 a
UF	0	9.62 e	0.93b	10.34 e	8.5 f	75.9 e	9.59 f
	I	10.76 c	0.92 b	11.70 c	10.3 c	87.3 c	11.72 c
	II	11.14 b	0.88 a	12.66 b	10.9 b	91.2 b	12.43 b

**U: Urea (46.5% N); U.F. :Urea formaldehyde (38.37% N) ; S.C.U.: Sulfur-coated urea (40% N)*

**Means in column followed by the same letter are not sign. different according to LSD. Test (P = 0.05).*

Conclusively, application of the dual save bio-fertilizers (VAM fungi at high rate and N in Sulfur coated urea form) to Balady Guava trees is highly recommended to enhance tree growth and consequently produce high yield with good marketing quality.

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