# COMPARATIVE STUDIES OF USING MINERAL AND BIO-FERTILIZERS ON GROWTH AND YIELD OF GUAVA

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## ABSTRACT

The present study was conducted during the two growing seasons 2003 and 2004 at the Agricultural Research Station, Faculty of Agriculture, Alexandria University, in order to investigate the effect of mineral fertilizers (NP) and biofertilizers (Biogene and Phosphorein) applied either alone or in combinations to nine years old guava trees on growth, yield, leaf mineral contents and fruit quality. The chemical fertilizers were applied at 4 different rates (0, 50, 75 and 100%). A full dose of mineral N+P fertilizers (100% mineral fertilizers) was 2 kg ammonium nitrate + 1 kg calcium superphosphate per tree. An amount of 200 g Biogene and 100 g Phosphorein per tree was added once (May) or in two equal doses (May and July) during both growing seasons. The obtained results are summarized as follows:

1. The application of 50 or 75% of chemical fertilizers + biofertilizers significantly increased leaf dry weight, P and K contents and yield as compared with the control.
2. Applying 75% mineral fertilizers + biofertilizers and 50% mineral fertilizers + biofertilizers increased fruit TSS and vitamin C contents in the second season, respectively.
3. Adding the recommended biofertilizers amount at two doses (May and July) did not differ significantly than one dose (May).

Finally, from the obtained results it could be recommended to inoculate guava trees with the biofertilizers of N and P to improve growth and yield as well as to reduce the amount of the NP mineral fertilizers.

## INTRODUCTION

In Egypt, the consumption per hectare of chemical fertilizers has reached about ten times more than average consumption of the whole world (FAO, 1994).

In recent years and because of the environmental awareness nowadays, the demand for minimizing the use of chemical fertilizers has directed the production techniques to use harmless, low polluted and less expensive fertilizers such as biofertilizers.

Biofertilizers are biological preparations that contain primarily potent strains of microorganisms which are safe for human, animal and environment (Ahmad *et al.*, 1997). They are capable of nitrogen fixation

(Ruiz-Lozano *et al.*, 1995) as well as enhancing availability of nutrients (Frankenberger and Arshad, 1995).

Recently, investigations on using biofertilizers to improve growth and productivity of different plant crops were reported (Barakat and Gabr, 1998; Mostafa, 2002 Helmy, 2003; Abd-Allah *et al.*, 2004 and Abd El-Mageed *et al.*, 2004). Additionally, the use of biofertilizers to increase growth and yield of several fruit trees is recommended (Haggag and Azzazy, 1996; Soliman, 2001; Abd El-Hamed, 2002 and Osman, 2003).

Guava is a vitamin C-rich fruit and is very popular to the Egyptian consumer because of its considerable price. Thus, the present work was undertaken to study the effect of Biogene and Phosphorein biofertilizers and different rates of nitrogen and phosphorus mineral fertilizers applied alone or in combinations on growth, leaf mineral content, yield and fruit quality of guava trees grown in sandy clay loam soil.

## MATERIALS AND METHODS

The present study was carried out during 2003 and 2004 successive seasons on 9 years old seedy guava trees (Psidium guajava L.) grown at the Agricultural Research Station, Faculty of Agriculture, Alexandria University. The soil was sandy clay loam with pH of 7.9-8.1. The physical and chemical characteristics of the soil are presented in Table (1). Trees were planted at 5 meters apart and fertilized with organic manure at a rate of 25 m3 per feddan in December of each year. Trees were selected as uniform as possible and received different mineral and bio-fertilizer applications. The mineral fertilizers were ammonium nitrate (33.5% N) and calcium superphosphate (15.5% P2O5). The biofertilizers were Biogene and Phosphorein, produced by the General Organization for Agricultural Equilization Found (GOAEF), Ministry of Agriculture, Egypt. The amount of ammonium nitrate was divided into two equal doses applied in May and Buly of both growing seasons. Calcium superphosphate was applied once in May of both seasons. The full dose of mineral N+P fertilizers (100% mineral fertilizers) was 2 kg ammonium nitrate + 1 kg calcium superphosphate per tree. The amounts of biofertilizers were 200 g Biogene and 100 g Phosphorein per tree, applied either once in May or divided into two equal doses in May and July during both 2003 and 2004 seasons. The experimental trees were subjected to seven treatments representing different applications of mineral and biofertilizers as follows:

1. Control (no fertilizers).
2. 100% mineral fertilizers (full dose).

3. 75% mineral fertilizers + biofertilizers applied in May.
4. 50% mineral fertilizers + biofertilizers applied in May.
5. 75% mineral fertilizers + biofertilizers applied in May and July.
6. 50% mineral fertilizers + biofertilizers applied in May and July.
7. Biofertilizers only applied in May and July.

Treatments were arranged in a randomized complete block design with 4 replications for each treatment using one tree as a single replicate (7 treatments x 4 replicates = 28 trees). Mineral fertilizers were broadcasted on the soil surface 1.0-1.5 m apart from the tree trunk. The biofertilizers were mixed with sand and broadcasted on soil surface and trees were irrigated after application. The yield as number and weight (kg) of fruits per tree was recorded at harvest time. In addition, a sample of 8 leaves was randomly selected from the middle part of non-fruiting shoots of each tree in both seasons. Leaves were washed with tap and distilled water, weighed and oven-dried at 65-70°C to a constant weight and leaf dry weight was calculated. The dried leaf tissues were grounded and digested with sulphuric acid and hydrogen peroxide as mentioned by Evenhuis and Dewaard (1980). Suitable aliquots were taken for the determinations of N, P and K. Nitrogen and phosphorus were determined colorimetrically according to Evenhuis (1976) and Murphy and Riley (1962). Potassium was determined by a flame photometer.

In order to determine fruit physical and chemical characteristics, a sample of 5 fruits was randomly taken from each tree at harvest time and averages of fruit weight, length and diameter were measured. Firmness was recorded by a pressure tester and the percentage of total soluble solids (TSS%) with a hand refractometer. Acidity (%) as citric acid and vitamin C (mg ascorbic acid/100 ml juice) were determined according to A.O.A.C. (1995). Finally, all data obtained were statistically analyzed according to Snedecor and Cochran (1980).

## RESULTS AND DISCUSSION

### Yield

The data presented in Table (2) showed that applying 75% mineral fertilizers + biofertilizers added in May and July significantly ifcreased the yield as number and weight of fruits in the first season. Moreover, the application of 50% mineral fertilizers + biofertilizers applied in May and July increased yield as number and weight of fruits, in both seasons, as compared with the control. This treatment showed an increase in average yield of both seasons as weight and number of fruits by a rate of 49.8 and 42.5%, respectively with regard to the control. In addition, no significant

differences between applying 50 and 75% mineral fertilizers + biofertilizers were obtained. These results are in agreement with those obtained by Akl *et al.*(1997) and Mansour (1998). They reported that Phosphorein, active dry yeast and Nitrobein were very effective in improving the yield. In addition, Gomez and Munoz (1998) stated that biofertilizers did not totally replace mineral fertilization, but they significantly reduce their rates of application.

**Leaf dry weight and mineral contents**

The data presented in Table 3 showed that leaf dry weight was significantly increased by adding 50% mineral fertilizers + biofertilizers applied in May or in May and July and 75% mineral fertilizers + biofertilizers applied in May and July, in both seasons, as compared with the untreated control. Moreover, no significant differences among the above mentioned treatments were obtained, in both seasons. These results are in line with those obtained by Soliman (2001) and El-Kholi *et al.*(2004a). This increment may be due to the ability of the microorganisms to produce growth regulator substances; i.e., indole acetic acid (IAA), gibberellic acid (GA) and cytokinens (CKs). These phytohormones play an important role in plant growth through promoting photosynthesis, translocation and accumulation of dry matter within different plant parts (Megahed and Mohamed, 2001). Also, the data in Table (3) showed that leaf N content was significantly increased by adding only biofertilizers in May and July, in the second season only. However, in both seasons, P was significantly increased by applying 75% mineral fertilizers + biofertilizers in May and July as compared with the control. In addition, leaf K content was not affected by any of the treatments, in the first season, whereas in the second season, leaf K content was significantly increased by adding 100% mineral fertilizers, 75% mineral fertilizers + biofertilizers applied in May and July and 50% mineral fertilizers + biofertilizers applied in May or in May and July (Table 3). However, no significant differences among the above mentioned treatments in leaf K content were observed. These results are in line with those reported by Haggag *et al.*(1996) and Helmy (2003). This improving effect of leaf N and P contents may be attributed to NP fertilization and also to that the bacteria present in the biofertilizers are working as N2-fixers (Biogene) and P dissolvers (Phosphorein) (Frankenberger and Arshad, 1995 and Ruiz- Lozano *et al.*, 1995). Also, Noel *et al.*(1996) reported that bacteria present in the biofertilizers secret promoting substances or organic acids that enhance nutrient uptake. Moreover, the hormonal exudates of the biofertilizers bacteria can modify root growth morphology and physiology, resulting in more absorption of nutrients (Monib *et al.*, 1990).

## Fruit physical and chemical properties

The data presented in Table (4) indicated that fruit length, diameter and firmness were not affected by any of the treatments, in both season when compared with the control. In contrast, Osman (2003) found that length and diameter of Zaghloul date were markedly increased with biofertilizer treatments. 50% mineral fertilizers + biofertilizers, applied in May increased fruit juice acidity when compared with the control in the first season only. However, applying 75% mineral fertilizers + biofertilizers added in May and July significantly increased TSS content (in the second season). Additionally, vitamin C content was significantly increased by applying 50% mineral fertilizers + biofertilizers added in May and July in the second season only. These results are in agreement with those reported by Mansour (1998), Osman (2003) and El-Kholi *et al.*(2004b).

In conclusion, applying 50% of the recommended dose of mineral NP fertilizers accompanied with biofertilizers could be recommended to improve growth and yield of guava trees.

## REFERENCES

**Abd-Allah, S.A.M.; S.M.A. Mansour and R.M. El-Saaid 2004).** Effect of bio and nitrogen fertilizer on okra. The Second International Symposium of Organic Agriculture, 25-27 March, 2004, El-Nasr City, Cairo, Egypt.

**Abd El-Hameed, A.A. (2002).** Response of Manzanillo olive trees to nitrogen and biofertilizer under North-Western Coast conditions. M.Sc. Thesis, Fac. Agric., Cairo Univ., Egypt, pp. 84-88.

**Abd El-Mageed, Y.T.; M.N.N. Hassan and R.H.M. Gheeth (2004).** Comparative studies of using chemical and bio-fertilizers on the growth and yield of two cultivars of snap bean. 1. Fresh yield and its components. The Second International Symposium of Organic Agriculture, 25-27 March, 2004, El-Nasr City, Cairo, Egypt.

**Ahmad, F.F.; A.M. Akl; F.M. El-Morsy and M.A. Ragab (1997).** The beneficial effects of biofertilizers on Red Roomy grapevines (Vitis vinifera L.). 1. The effect on growth and vine nutritional status. Ann. Agric. Sci., Moshtohor, 35 (1): 489-495.

**Akl, A.M.; F.F. Ahmed; F.M. El-Morsy and M.A. Ragab (1997).** The beneficial effects of biofertilizers on Red Roomy grapevines (Vitis

vinifera L.). II. The effect on berry set, yield and quality of berries. Ann. Agric. Sci., Moshtohor, 35 (1): 497-502.

**A.O.A.C. (Association of Official Agricultural Chemists) (1995).** Official of Methods of Analysis. 15th Ed. Published by A.O.A.C., Washington, DC (USA).

**Barakat, M.A.S. and S.M. Gabr (1998).** Effect of different biofertilizer types and nitrogen fertilizer levels on tomato plants. Alex. J. Agric. Res., 43 (1): 149-160.

**El-Kholi, M.M.A.; A.N. Ibrahim and M.H. Ali (2004a).** Influence of bio and nitrogen fertilizer on sugar beet growth. The Second International Symposium of Organic Agriculture, 25-27 March, 2004, El-**Nasr** City, Cairo, Egypt.

**El-Kholi, M.M.A.; A.M.A. Shatta and M.H. Ali (2004b).** Influence of bio and nitrogen fertilizer on yield and sugar quality of sugar beet. The Second **International** Symposium of Organic Agriculture, 25-27 March, 2004, El-Nasr City, Cairo, Egypt.

**Evenhuis, B. (1976).** Nitrogen determination. Dept. Agric. Res., Royal Tropical Inst., Amsterdam.

**Evenhuis, B. and P.W. Dewaard (1980).** Principles and practices in plant analysis. FAO Soils Bull., 38 (1): 152-163.

FAO (1994). Fertilizer Year-Book, 44.

**Frankenberger, W.T. and M.J.R. Arshad (1995).** Phytohormones in soils (Microbial production and function). Marcel Dekker, Inc. Publishers, 270 Madison Avenue, New York, USA.

**Gomez, R. and H.A. Munoz (1998).** Biofertilization of garlic (Allium sativum L.) on a compacted red ferralitic soil. Cultivos Tropicales, 19 (2): 9-13.

**Haggag, L.F. and A.M.A. Azzazy (1996).** Evaluation of microbein as a multi-strains biofertilizer for production of improved mango seedlings with appropriate vigour for grafting in shorter time. Annals Agric. Sci., Ain Shams Univ., Cairo, 41 (1): 321-331.

**Helmy, Laila M. (2003).** Studies on the effect of irrigation intervals, Bio- and chemical fertilization on Roselle plant productivity. J. Agric. Sci. Mansoura Univ., 28 (5): 3927-3945.

**Mansour, A.E.M. (1998).** Response of Anna apples to some biofertilizers. Egypt. J. Hort., 25 (2): 241-251.

**Megahed, M.A.M. and S.G.A. Mohamed (2001).** Evaluation of barley yield under some biofertilizers and nitrogen treatments using statistical parameters. Zagazig J. Agric. Res., 28 (6): 991-1008.

**Mostafa, M.M. (2002).** Effect of biofertilizer, salinity and magnetic technique on the growth of some annual plants. Alex. J. Agric. Res., 47 (2): 151-162.

**Monib, M.; M. Saber; A.M. Gomma and N.A. Hegazi (1990).** Enrichment of tomato sand culture with composite inocula of associative dinitrogen fixers, P-dissolving bacilli and VAM. Skinner, F.A. et al.(eds.), Nitrogen Fixation with Non-legumes, 25: 317-319.

**Murphy, J. and J.P. Riley (1962).** A modified single solution method for the determination of phosphorus in natural water. Ann. Chem. Acta., 27: 31-38.

**Noel, T.C., C. Cheng; C.K. Yost; R.P. Pharis and M.E. Hynes (1996).** Rhizobium leguminosarum as a plant growth promotion of canola and lettuce. Can. J. Microbial., 42 (3): 279-283.

**Osman, S.M. (2003).** Effect of biofertilization on fruit physical and chemical properties of Zaghloul date palm. Annals Agric. Sci., Ain Shams Univ., Cairo, 48 (1): 297-305.

**Ruiz-Lozano, J.M.; R. Azcon and M. Gomez (1995).** Effect of arbuscular mycorrhizal Glomus species on drought tolerance: physiological and nutritional plant responses. Appl. Environ. Microbiol. (Bull. Monthly by Am. Soc. for Microbiol.), 16 (2): 456-460.

**Snedecor, G.W. and W.G. Cochran (1980).** Statistical Methods. 6th ed., Iowa State Univ. Press, Ames, Iowa, USA.

**Soliman, M.G.A. (2001).** Response of banana and guava plants to some biological and mineral fertilizers. M.Sc. Thesis, Fac. of Agric., Alex. Univ., Egypt.

**Table (1): Soil analysis of the experimental orchard.**

| Soil depth (cm) | Texture | E.C mmhos /cm | pH | Cations (meq/l) | | | | Anions (meq/l) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{-}$ |
| 0-30 | S.C.L. | 1.88 | 8.1 | 6.76 | 3.74 | 8.7 | 0.86 | 4.7 | 6.83 | 8.58 |
| 30-60 | S.C.L. | 1.77 | 8.1 | 4.06 | 3.32 | 10.2 | 0.52 | 1.8 | 7.23 | 9.27 |
| 60-90 | S.C.L. | 1.54 | 7.9 | 3.86 | 3.77 | 18.4 | 0.46 | 1.6 | 10.30 | 9.79 |

S.C.L. = Sandy clay loam.

**Table (2): The effect of bio- and mineral fertilizers on yield as number and weight of fruits of guava in 2003 and 2004 seasons.**

| Treatments | 2003 season | | 2004 season | |
|---|---|---|---|---|
| | No. of fruits per tree | Weight of fruits per tree (kg) | No. of fruits per tree | Weight of fruits per tree (kg) |
| Control (no fertilizer) | 271.3 | 32.7 | 381.0 | 49.6 |
| 100% mineral fertilizers (full dose) | 333.0 | 50.8 | 400.0 | 56.3 |
| 75% mineral fertilizers + biofertilizers applied in May | 408.0 | 58.0 | 414.0 | 57.8 |
| 50% mineral fertilizers + biofertilizers applied in May | 427.8 | 59.0 | 516.0 | 70.9 |
| 75% mineral fertilizers + biofertilizers applied in May and July | 474.0 | 79.1 | 422.0 | 71.5 |
| 50% mineral fertilizers + biofertilizers applied in May and July | 533.0 | 79.6 | 594.0 | 83.3 |
| Biofertilizers only applied in May and July | 477.0 | 55.0 | 470.5 | 56.9 |
| L.S.D0.05 | 163.5 | 28.4 | 147.9 | 28.2 |

**Table (3): The effect of bio- and mineral fertilizers on leaf dry weight and N, P and K contents of guava in 2003 and 2004 seasons.**

| Treatments | 2003 season | | | | 2004 season | | | |
|---|---|---|---|---|---|---|---|---|
| | Leaf dry weight (g) | N (%) | P (%) | K (%) | Leaf dry weight (g) | N (%) | P (%) | K (%) |
| Control (no fertilizer) | 6.13 | 1.23 | 0.40 | 1.20 | 3.63 | 1.34 | 0.37 | 1.60 |
| 100% mineral fertilizers (full dose) | 7.23 | 1.40 | 0.47 | 1.41 | 4.23 | 1.46 | 0.44 | 1.96 |
| 75% mineral fertilizers + biofertilizers applied in May | 7.30 | 1.45 | 0.45 | 1.60 | 4.33 | 1.45 | 0.39 | 1.87 |
| 50% mineral fertilizers + biofertilizers applied in May | 8.80 | 1.54 | 0.48 | 1.43 | 5.03 | 1.60 | 0.42 | 1.99 |
| 75% mineral fertilizers + biofertilizers applied in May and July | 9.60 | 1.49 | 0.60 | 1.49 | 5.38 | 1.61 | 0.50 | 1.95 |
| 50% mineral fertilizers + biofertilizers applied in May and July | 9.20 | 1.40 | 0.51 | 1.50 | 5.20 | 1.60 | 0.47 | 2.02 |
| Biofertilizers only applied in May and July | 6.75 | 1.40 | 0.51 | 1.23 | 4.13 | 1.71 | 0.43 | 1.92 |
| L.S.D0.05 | 2.57 | 0.38 | 0.12 | 0.54 | 1.37 | 0.31 | 0.12 | 0.33 |

# الملخص العربي

## دراسات مقارنة على استخدام الأسمدة المعدنية والحيوية على نمو ومحصول الجوافه

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أجريت هذه الدراسة الحقلية خلال موسمى 2003 و 2004 بمحطة البحوث الزراعية، كلية الزراعة، جامعة الاسكندرية وذلك لدراسة تأثير التسميد المعدنى (نيتروجين وفوسفور) والتسميد الحيوى (بيوجين وفوسفورين) مضافين منفردا أو معاً على النمو والمحصول ومحتوى الأوراق من العناصر وصفات جودة ثمار أشجار جوافة عمر 9 سنوات. وقد أضيف السماد المعدنى بأربعة معدلات (100%، 75%، 50%، صفر) وكانت الجرعة الكاملة من السماد المعدنى 2 كجم نترات أمونيوم + 1 كجم سوبرفوسفات الكالسيوم لكل شجرة. وأضيف السماد الحيوى بيوجين بمعدل 200 جرام والفوسفورين بمعدل 100 جرام لكل شجرة إما دفعة واحدة فى شهر مايو أو على دفعتين متساويتين فى شهرى مايو ويوليو فى كلا موسمى النمو. ويمكن تلخيص أهم النتائج فيما يلى:

1- أدت المعاملة بالسماد المعدنى بنسبة 50% أو 75% + التسميد الحيوى إلى زيادة معنوية فى الوزن الجاف للأوراق ومحتواها من عنصرى الفوسفور والبوتاسيوم وفى كمية المحصول بالمقارنة بالكنترول.

2- أدت المعاملة بـ 75% سماد معدنى + سماد حيوى إلى زيادة محتوى المواد الصلبة الذائبة الكلية فى الثمار فى الموسم الثانى. كما أن 50% سماد معدنى + سماد حيوى أدى إلى زيادة المحتوى من فيتامين ج فى الموسم الثانى فقط.

3- لم يوجد فرق معنوى بين إضافة السماد الحيوى مرة واحدة فى شهر مايو أو على دفعتين فى شهرى مايو ويوليو على معظم الصفات المدروسة.

ومن النتائج المتحصل عليها يمكن التوصية بإضافة السماد الحيوى لأشجار الجوافة لزيادة النمو والمحصول وكذلك لخفض كمية السماد المعدنى النيتروجينى والفوسفورى إلى حوالى 50% من الجرعة الموصى بها.