

Effect of bio and organic fertilization on growth, productivity, fruit quality and leaf mineral content of grand Nain Banana

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ABSTRACT

This investigation was undertaken on Grand Nain banana grown in clay soil under surface irrigation system to study the effect of fluorescent pseudomonas bacteria as biofertilizer and Farmyard manure (FYM) on growth, yield, fruit quality and leaf mineral content of Grand Nain banana. The obtained results indicated that fluorescent pseudomonas bacteria which added as biofertilizer and FYM application significantly increased pseudostem height girth, number of green leaves, total leaf area, bunch weight, number of hands and finger per bunch, finger weight, length and diameter, total soluble solids, Acidity, total sugar and starch. The contents of leaves from nitrogen, phosphorus and potassium increased by increasing the rates of biofertilizer and FYM. The fruit physical properties were improved by the application of FYM and biofertilizer.

Key words: Biofertilizer, *Pseudomonas fluorescens*, Farmyard manure (FYM) and Grand Nain banana.

INTRODUCTION

Banana are considered one of the most important commercial fruits in Egypt. Recently, there are an increasing demand for banana to meet the need of local as well as the foreign market of some Arabic countries.

Nowadays, great attention has been focused on the possibility of using natural and safety substances to enhancing growth and fruit quality. The economical and environmental problems of using the chemical fertilizers were reduced and can be avoided by using the biofertilizers. The biofertilizers not only increase soil fertility and crop production through enhancing nutrient supply, but also to save foreign currency for Egypt (El-Ghandour, 1992). Fernandez-Falcon *et al.*, (1998) revealed that the addition of a liquid suspension from RET-FLOPX 357 a commercial mixture of microorganisms to the banana cv. Dwarf cavendish, increased phosphorus content in leaves and roots.

Chezhiyan *et al.* (1999) showed that treating hill banana cv. Virupakshi with inorganic fertilizers was effective in increasing bunch weight. Alonso-Reyes *et al.* (1995) reported that the plant height of banana cv. parricidal Rey which inoculated with *Glomus fasciculatum* and Phosphate mobilizing bacterium (MOSP pseudomonas fluoresces) was greatly increased than that in control. Using biofertilizers and FYM as a source of nitrogen requirements for Grand Nain banana plants may reduce the environmental pollution resulted from using chemical nitrate fertilizers which leached into the soil and transferred through the plants to the human or animal and causes serious diseases.

The main purpose of this investigation was to study the effect of biofertilizer and farmyard manure (FYM) application on growth, yield, fruit quality and leaf mineral contents of Grand Nain banana (Alten *et al.*, 1998; Ebrahiem and Mohamed, 2000).

MATERIALS AND METHODS

This investigation was carried out through two successive seasons of 2001/2002 and 2002/2003 on Grand Nain cv. banana plants (*Musa cavendishii* L.) grown in a private orchard at Manfalot, Assiut Governorate, Egypt. The main physical and chemical properties of the orchard soil are shown in Table (1). The soil analysis was carried according to the methods described in Chapman and Pratt (1961). This orchard was irrigated with Nile water by the surface irrigation method. The experimental work was conducted on the second and third ratoons. In both seasons, the mother plants were removed and two off shoots were selected in each hole (spacing of 3 x 3 m) in order to prepare those plants to carry out the present experiment. Each treatment was represented by 9 holes distributed in three blocks in a complete randomized block design, three holes of each block received one of the following treatments:

1. The recommended nitrogen rate in the form of farmyard manure (FYM) as 50 kg/plant/year (control).
2. 50 kg FYM + 1 L. biofertilizer/plant/year
3. 75 kg FYM + 1 L. biofertilizer/plant/year
4. 100 kg FYM + 1 L. biofertilizer/plant/year
5. 50 kg FYM + 2 L. biofertilizer/plant/year
6. 75 kg FYM + 2 L. biofertilizer/plant/year
7. 100 kg FYM + 2 L. biofertilizer/plant/year
8. 50 kg FYM + 3 L. biofertilizer/plant/year
9. 75 kg FYM + 3 L. biofertilizer/plant/year
10. 100 kg FYM + 3 L. biofertilizer/plant/year

Biofertilizer:

The biofertilizer were obtained from Microbiology Research Center, Cairo Mircen, Egypt [EMCC], Fac. of Agric., Ain Shams Univ., Cairo, Egypt. This biofertilizer (*Pseudomonas fluorescents-putida*) was used to inoculate each plant (one ml of biofertilizer contain 10^7 cells).

Table (1). Some physical and chemical properties of the experimental soils.

Soil properties	0-30 cm	30-60 cm	60-90 cm
<u>Particle-size distribution:</u>			
Sand %	24.0	21.8	19.7
Silt %	35.4	36.2	34.9
Clay %	40.6	42.0	45.4
Texture class	Clay	Clay	Clay
Soil pH (Soil Paste)	7.34	7.38	7.41
EC (dS/m)	4.41	5.01	6.81
<u>Soluble cations (meq/100 g soil)</u>			
Ca ⁺⁺	0.75	0.68	0.82
Mg ⁺⁺	0.67	0.75	0.94
Na ⁺⁺	1.98	2.47	2.43
K ⁺	0.03	0.02	0.03
<u>Soluble Anions (meq/100 g soil)</u>			
CO ₃ ⁻⁻	--	--	--
HCO ₃ ⁻	0.29	0.28	0.20
Cl ⁻	1.55	1.83	2.20
SO ₄ ⁻⁻	1.59	2.22	2.72
Organic matter content, %	2.15	1.80	1.32
CaCO ₃ %	2.19	2.28	2.45
CEC, meq/100 g soil	37.92	38.15	38.36

PGPR (Plant growth promoting rhizobacteria) are a commercial mixture of microorganisms to the banana which added as a liquid suspension.

Farmyard manure:

The chemical analysis of farmyard and manure was carried out according to the methods described by Page *et al.* (1982). The chemical properties of the farmyard manure are shown in Table 2.

Farmyard manure (FYM) was added to surface soil followed by tillage at the end of November, but the biofertilizer was added at the end of January in form of solution from (1-3) L/4 trenches/plant/year. After adding biofertilizer, surface irrigation was used directly in both season. Through this study, various determinations were carried out as follows:

1. Vegetative growth:

After the emergence of the inflorescence (second week of August 2001 and 2002) pseudostem height (from ground level to the top of the curve of the bunch stalk) and pseudostem girth (20 cm above ground level) were number of green leaves was counted. Total leaf area (cm²) was measured according to Ahmed and Morsy (1999) using the formula:

$$LA = 0.67 (L \times W) + 107.15$$

Where *L* = leaf

A – area

W = width

2. Bunch and finger parameters:

At harvest time, bunch weight (kg), number of hands and fingers per bunch, finger weight (g), finger length (cm) and finger diameter (cm) were calculated.

3. Chemical properties:

After artificial ripening, total soluble solids (T.S.S., %), total acidity % (as g malic acid/100 g pulp), total and reducing sugar %, and starch % were determined according to A.O.A.C. (1995).

4. Leaf minerals contents:

At bunch shooting stage, leaf sample were taken from the third upper leaf in the succession of leaves from the top of the plant as recommended by Simmonds (1966) and adopted by Abou Aziz *et al.* (1987). Percentage of N, P and K were determined on dry weight basis according to Wilde *et al.* (1979).

Table (2). Some chemical properties of the used farmyard manure.

Organic material	Organic matter, %	Organic carbon, %	Total Nitrogen %	C/N ratio	mg/100 g			µg/100 g		
					N	P	K	Mn	Fe	Zn
Farmyard manure (FYM)	14.00	8.12	0.50	16/1	145	50.10	0.60	11.30	4.80	0.79

5. Statistical Analysis:

All the obtained data were tabulated and statistically analyzed according to Snedecor and Cochran (1972) using L.S.D. test at 0.01 and 0.05.

RESULTS AND DISCUSSION

Vegetative growth:

The results presented in Table (3) indicate that increasing the application rates of farmyard manure and biofertilizers showed significantly increase in height and girth of pseudostem, number of green leaves as well as leaf area with 100 kg FYM + 3 L. Bio. than other treatments during two seasons. The positive role of the biofertilizer, it could be attributed to the role nitrogen fixing bacteria which supplied the soil and plants by the available nitrogen to absorb and use of metabolism in the plant. Also, the positive effect of farmyard manure could be due to its content of N, P, K, Mn, Fe and Zn (Table 2). The results are in harmony with Alvarez *et al.* (1993), Soliman (2001) and El-Shenawi and Hassouna (2004).

Table (3). Effect of farmyard and biofertilizer rates on vegetative growth of "Grand Nain " banana plants.

Treatments	Pseudostem height (cm)		Pseudostem girth (cm)		No. of green leaves		Leaf area (m ²)	
	2002	2003	2002	2003	2002	2003	2002	2003
50 kg FYM/ plant/year	250	251	70.0	72.0	9.7	10.3	21.7	23.3
50 kg FYM + 1 L Bio.	255	256	76.0	76.7	10.7	11.0	24.7	26.0
75 kg FYM + 1 L Bio.	259	261	77.7	79.0	11.7	11.7	25.7	26.7
100 kg FYM + 1 L Bio.	263	263	81.0	83.3	12.7	13.0	26.7	27.3
50 kg FYM + 2 L Bio.	265	265	82.3	85.0	13.7	14.0	28.0	28.3
75 kg FYM + 2 L Bio.	270	271	84.0	86.7	15.0	15.3	28.7	29.7
100 kg FYM + 2 L Bio.	275	276	85.3	88.0	16.0	16.3	30.0	31.7
50 kg FYM + 3 L Bio.	282	282	87.3	90.0	15.3	16.7	31.3	33.3
75 kg FYM + 3 L Bio.	288	292	89.7	92.7	17.7	18.0	32.3	35.3
100 kg FYM + 3 L Bio.	296	295	91.7	95.0	18.3	18.7	33.7	36.3
L.S.D. _{0.05}	3.40	2.97	1.81	1.54	1.34	0.80	0.92	1.57
L.S.D. _{0.01}	4.70	4.07	2.48	2.11	1.84	1.10	1.27	2.18

Yield characters:

Data in Table (4) indicated that application of farmyard manure and biofertilizer (100 kg FYM + 3L. Bio.) to banana plants caused significant increase on yield characters in the two seasons. Bunch weight, number of hands/bunch, number of fingers/bunch, finger weight, finger length and finger diameter. It could be concluded that bio- and organic fertilizers treatments promote the production banana plants. Once roots emerge at seedling germination and are colonized by N₂-fixing bacteria energetic pathway such as glycolysis and conversion of conjugate (IAA) to active (IAA) are stimulated also, the nitrogen fixing-bacteria may increase the synthesis of the endogenous photohormones i.e. (IAA), (GAS) and (CKS) which play an important role in formation of or big active root system allow more nutrients uptake and hence may promote photosynthesis and translocation as well as accumulation of dry matter within different plants and hence increased the number of hands/bunch and finger weight. These results are agreement with Smith (1998), Chezhiyan *et al.* (1999), Abd El-Naby (2000), Geetha and Nair (2000), Magda (2002) and El-Shenawi and Hassouna (2004).

Table (4). Effect of farmyard manure and biofertilizer rates on yield properties of "Grand Nain " banana plants.

Treatments	Bunch weight (kg)		No. of hands / bunch		No.of finger/ bunch		Finger weight (g)		Finger length (cm)		Finger diameter (cm)	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
50 kg FYM/ plant/year	20.3	21.3	9.7	10.3	148.3	155.0	84.0	85.7	14.3	14.7	2.57	2.70
50 kg FYM + 1 L Bio.	22.3	23.0	11.3	11.7	158.3	160.7	87.0	88.0	14.7	15.3	2.90	3.00
75 kg FYM + 1 L Bio.	24.0	24.3	11.7	12.0	163.3	166.3	89.0	91.0	15.3	16.3	3.23	3.40
100 kg FYM + 1 L Bio.	26.0	26.3	12.3	12.7	173.3	175.7	91.0	92.7	15.7	16.7	3.40	3.63
50 kg FYM + 2 L Bio.	27.7	28.3	12.7	13.3	178.3	181.3	91.7	94.3	16.3	17.0	3.53	3.73
75 kg FYM + 2 L Bio.	29.7	30.7	13.3	13.7	185.0	187.7	94.0	96.0	16.7	18.0	3.67	3.80
100 kg FYM + 2 L Bio.	31.7	32.7	14.3	14.0	187.7	192.3	95.7	98.3	17.3	19.7	3.73	3.90
50 kg FYM + 3 L Bio.	33.0	34.0	14.3	14.0	210.0	209.0	101.3	104.0	17.7	21.0	4.20	4.33
75 kg FYM + 3 L Bio.	36.3	37.0	14.7	15.0	220.0	220.0	105.7	108.0	19.3	21.7	4.50	4.63
100 kg FYM + 3 L Bio.	39.0	39.7	15.0	15.0	233.3	237.0	112.7	114.3	20.3	22.7	4.73	4.83
L.S.D. _{0.05}	1.37	1.18	0.91	0.59	8.22	5.30	2.49	1.81	1.04	1.24	0.11	2.3
L.S.D. _{0.01}	1.88	1.51	1.24	0.81	11.27	7.27	3.42	2.43	1.43	1.70	0.15	3.15

Fruit chemical properties:

Results in Table (5) declared that the total sugars, starch, acidity and total soluble solids significantly increased by increasing the rates of biofertilizer and farmyard manure in both seasons but the reducing sugars

was decreased by increasing the rates of biofertilizer and farmyard manure. Thus, the lowest organic fertilizer increased reducing sugars through increasing gross sugar content and lowering impurities. These results are in accordance with that obtained by Chezhiyan *et al.* (1999), Joo *et al.* (1999), Abd El-Naby (2000), Abd El-Aziz (2000) and Magda (2002).

Table (5). Effect of farmyard manure and biofertilizer rates on fruit chemical characters of "Grand Nain" banana plants.

Treatments	Total sugars (%)		Reducing sugars (%)		Starch (%)		Acidity (%)		T.S.S.	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
50 kg FYM/ plant/year	15.23	14.76	7.20	7.60	1.32	1.37	0.29	0.30	15.30	15.70
50 kg FYM + 1 L Bio.	16.27	16.67	6.87	7.00	1.41	1.52	0.31	0.32	16.00	16.70
75 kg FYM + 1 L Bio.	16.67	17.00	6.50	6.73	1.47	1.56	0.32	0.34	16.70	17.00
100 kg FYM + 1 L Bio.	16.83	17.20	6.23	6.40	1.57	1.65	0.34	0.35	18.00	17.70
50 kg FYM + 2 L Bio.	17.50	18.20	6.00	6.10	1.69	1.80	0.34	0.36	19.00	20.00
75 kg FYM + 2 L Bio.	18.26	19.43	5.93	6.00	1.76	1.87	0.35	0.37	20.00	21.00
100 kg FYM + 2 L Bio.	18.73	19.73	5.73	5.83	1.84	2.00	0.36	0.39	20.70	21.00
50 kg FYM + 3 L Bio.	19.73	20.20	5.40	5.57	1.89	2.33	0.40	0.42	21.20	22.00
75 kg FYM + 3 L Bio.	21.97	22.10	5.20	5.27	1.97	2.43	0.42	0.43	22.30	23.00
100 kg FYM + 3 L Bio.	22.90	23.73	5.00	5.10	2.03	2.63	0.44	0.45	23.00	23.70
L.S.D. _{0.05}	0.59	0.57	0.17	0.21	0.12	0.94	0.016	0.017	1.26	1.26
L.S.D. _{0.01}	0.81	0.78	0.23	0.29	0.17	1.29	0.022	0.024	1.73	1.73

Leaf mineral contents:

Results in Table (6) revealed that increasing the rates of farmyard manure and biofertilizer were associated with a gradual and significant increase in the percentage of N, P and K in the leaves of Grand Nain banana in both line. These results were similar Soliman (2001); Magda (2002) and El-Shenawi (2000).

Table (6). Effect of farmyard manure and biofertilizer rates on N, P and K concentration of "Grand Nain " banana plants grown in clay soil.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	2002	2003	2002	2003	2002	2003
50 kg FYM/ plant/ year	2.63	2.50	0.21	0.20	2.04	2.08
50 kg FYM + 1 L Bio.	2.87	2.67	0.22	0.22	2.05	2.07
75 kg FYM + 1 L Bio.	2.97	2.83	0.24	0.26	2.23	2.30
100 kg FYM + 1 L Bio.	3.30	3.10	0.26	0.29	2.28	2.35
50 kg FYM + 2 L Bio.	3.13	3.17	0.22	0.23	2.05	2.09
75 kg FYM + 2 L Bio.	3.21	3.27	0.25	0.27	2.26	2.28
100 kg FYM + 2 L Bio.	3.27	3.33	0.26	0.29	2.27	2.37
50 kg FYM + 3 L Bio.	3.33	3.40	0.22	0.23	2.13	2.09
75 kg FYM + 3 L Bio.	3.40	3.47	0.23	0.26	2.28	2.37
100 kg FYM + 3 L Bio.	3.50	3.53	0.27	0.29	2.37	2.41
L.S.D. _{0.05}	0.097	0.14	0.011	0.107	0.054	0.071
L.S.D. _{0.01}	0.013	0.13	0.015	0.147	0.074	0.097

CONCLUSION

Biofertilizer and FYM increased the vegetative growth, yield, chemical properties (quality) and leaf mineral content (NPK) of Grand Nain banana.

It will keep out environment clean, decreasing the environment pollution and fertilizers lost from applying high fertilizer rates.

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الملخص العربي

تأثير التسميد الحيوي والعضوي على النمو ، وإنتاجية وجودة الثمار والمحتوى

المعدني لأوراق الموز صنف جرانندان

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أجرى هذا البحث خلال عامي 2001/2002 ، 2002/2003 على صنف الموز جرانندان النامية في تربة طينية تحت نظام الري السطحي لدراسة تأثير التسميد الحيوي والعضوي على النمو الخضري والمحصول وجودة ومحتوى الأوراق من عنصر النيتروجين والفوسفور والبوتاسيوم . أوضحت النتائج أن إضافة التسميد الحيوي البكتيري والعضوي سبب زيادة معنوية في طول وقطر الساق الكاذبة وعدد الأوراق الخضراء والمساحة الورقية ووزن السباطة وعدد الكفوف لكل سباطة وعدد الأصابع لكل سباطة ووزن الصوبع وطول الصوبع وقطر الصوبع . كذلك زاد محتوى الأوراق من عنصر النيتروجين والفوسفور والبوتاسيوم بزيادة معدل التسميد الحيوي والعضوي . أيضا زادت نسبة السكريات الكلية والحموضة والنشا والمواد الصلبة الذائبة الكلية وانخفضت نسبة السكريات المختزلة بزيادة معدل التسميد الحيوي والعضوي .