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EFFECT OF MINERAL AND BIO-ORGANIC FERTILIZATION ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF BANANA PLANTS

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ABSTRACT

This investigation was carried out during two successive seasons of 2004 and 2005 to study the effect of fertilization by using two types of organic manures, i.e. cattle or town refuse at different levels (50, 75 and 100%) from its recommended dose with or without biofertilizers mixture, i.e. microbien and phosphoren in combination with 50% mineralized NPK on growth, chemical composition as well as yield and its quality of Grand Nain banana plants in comparison to banana plants only fertilized with mineralized 100% NPK of the recommended dose. The best results obtained that from banana plants inoculated and fertilized with cattle manure at rate of 100% . In addition, biofertilizers with organic manure improved growth, chemical composition as well as fruit yield and its quality. Increasing the rate of either organic manure with or without inoculation had a positive increment on all studied parameters, especially with the high rate. Chemical constituents of Grand Nain banana fruits were greatly improved as a result of using N in both organic and mineral sources rather than adding N completely via only mineral source. Organic fertilization with cattle or town refuse had a favorable effects on fruit quality since in increase finger weight and concentration of soluble solids and total sugar as well as decreasing concentration of starch and nitrate in fruits except the high rate of town refuse. Organic fertilization by using cattle manure at the rate of 100% combined with 50% mineralized NPK of the recommended rate and inoculated by biofertilizers gave the best results with all studied characteristics of Grand Nain banana plants .

INTRODUCTION

Banana is one of the most important and popular fruit crops in Egypt and for its high nutritive value . Banana plays an important role in tropical economics as a cash export and as complementary food in local sets. It is well known that banana needs large amounts of fertilizers especially nitrogen and potassium . Among these nutrients nitrogen is considered the prime nutrient for growth of plants. Fertilization is an important and limiting factor for growth and productivity of banana plants because plants consumed large amounts of nutrients from the soil . Moreover , it drew nutrient elements from a very limited soil depth due to its shallow roots system (Saleh, 1996). Also, high water requirements caused a great leaching of most applied nutrients, particularly of nitrogen besides, its volatilization and denitrification .So, the major problems facing banana growers are the high costs of excessive manufactured fertilizers needs for banana plants . Besides, these chemical fertilizers are considered air, soil and water pollutant agents during their producing and utilization . The pollution of soil and water resulted from leached chemical fertilizers into the soil, which transferred through the plants

to the human and causes serious diseases. This problem draws the attention of banana researchers and growers to use organic and biofertilizers which could be more save for human and environment . Thus, its avoided this pollution and reduced the costs of fertilizers (Kamel, 2002). Organic fertilizer is another option for supplying nutrient elements to banana . In addition, integrated nutrient management methods, combining mineral and organic nutrients sources, offer better results of banana productivity than reliance on one source alone (Bekunda, 1999). Also, inoculation with bio- fertilizers could save half the normal field rate of N chemical fertilizers and at the same time promote plant production (Ischac and Mostafa 1989). Moreover, Chezhiyan *et al.* (1999) fertilized banana plants cv.Virupakshi with 75 % NPK, farmyard manure and *Azospirillum* showed that this application was more effective in increasing bunch weight comparing with using 100% NPK .Also, Hammam (2003) mentioned that using N via mineral source and mixture with *Azotobacter* and *phosphate solublizing bacteria* significantly in improving fruit quality of Williams and Cavendish bananas in increasing SSC and total sugar and decreasing the percentage of starch and total acidity as compared with using N completely.

The aim of this research was to study the effect of fertilizating with 50% NPK combined with cattle or town refuse manure with or without biofertilizers on growth characters, yield, fruit quality and leaf mineral concentration of Grand Nain banana plants compared to using fertilized with 100% NPK only.

MATERIALS AND METHOD

This investigation was carried out during two successive seasons of 2004/2005 and 2005/2006 on the second and third ratoons of Grand Nain banana plants (produced through tissue culture technique from institute of Horticulture Search Laboratory) grown in a private orchard situated at Aly Mobark rigion, Badr District, Behera Governorate. Banana plants were cultivated in square system of three meters apart, similar in growth, free from any diseases and received to the same horticultural managements. Soil is sandy in texture under drip irrigation system.

Physical and chemical analysis of the soil: The soil samples were collected from different location in the plantation at 0.0–60 cm, depth and analysis for physical and chemical characters was done according to Wild *et al.* (1985) and the data are shown in Table (1).

To evaluate the response of Grand Nain banana plants to organic manures, biofertilizers and chemical fertilizers, sixty five of Grand Nain banana plants each in separated stool, were chosen and arranged in complete randomized block design on thirteen treatments. Each treatment was represented by five replicates, each replicate are represented by one stool. In the first season, each stool yielded three suckers. Also, in the second season, each stool yielded three suckers .

In both seasons, the experiment included 13 treatments as follows :

1-Control treatment only fertilized with 100 % recommended NPK mineral fertilizers,i.e. 400 kg N/fed. (1200 Kg ammonium nitrate 33.5 % N / fed./year),

50 kg P_2O_5 /fed. (250 Kg calcium superphosphate 15.5% P_2O_5 / fed./year and 52 mL. phosphoric acid 80% /fed./year) and 800 kg K_2O / fed. (1600 Kg potassium sulphate 48% K_2O / fed. /year.)
2-4- 50 % of the recommended NPK fertilizers plus cattle manure at the rate of 12.5, 18.75 and 25 kg /plant.
5-7- 50 % of the recommended NPK fertilizers plus cattle manure at the rate of 12.5, 18.75 and 25 kg /plant with biofertilizer .
9-11- 50 % of the recommended NPK fertilizers plus town refuse manure at the rate of 16 , 24 and 32 kg /plant.
11-13- 50 % of the recommended NPK fertilizers plus town refuse manure at the rate of 16, 24 and 32 kg /plant with biofertilizer.

Table(1): Physical and chemical analysis of orchard soil (0 – 60 cm, depth) during season of 2004 .

Physical character	value	Chemical constituent	Value
		Available macro- element (%)	
Clay %	4.35	N	0.90
Silt %	3.40	P	0.28
Sand %	90	K	0.36
Texture	Sand	Available micro -element (ppm)	
Ec mm hos/cm 1:2.5	1.5	Zn	0.28
pH	8.29	Fe	2.38
Organic matter%	0.65	Mn	0.58
$CaCO_3$ %	1.60		

Table(2): Chemical analysis of cattle and town refuse manures.

Organic manure	Organic matter%	Total N %	Total P %	Total K %	Fe (ppm)	Mn (ppm)	Zn (pp)	Ni (ppm)	Pb (ppm)	Cd (ppm)
Cattle	37.41	1.61	0.63	1.27	6499	264	250	5.60	5.20	2.19
Town refuse	32.85	1.25	0.35	0.69	1959	275	382	12.0	12.5	3.25

Fertilization programme :. for both 50 or 100% of the recommended NPK, microelements were also added in each season in the form of Zn sulphate (5 kg/fed.), Mn sulphate (5 kg/fed.) and Fe chilate (3kg/fed.) . Organic manures were mixed with the soil root zone of each plant during the first week of December in both studied seasons. The chemical analysis of two organic manures were shown in Table (2).

The biofertilizer included two commercial types, namely microbien and phosphoren. Microben is the commercial name of "N- fixation bacteria contained *Azotobacter* + phosphorus dissolving bacteria *Bacillus brevis*. The other biofertilizer phosphoren contained only phosphorus dissolving bacteria *Bacillus megateriam*. Both biofertilizers were added as a liquid suspension at rate of 5 L. / fed. during the first week of April for each season . One ml of biofertilizer contained 10^8 cells according to the General Organization for Agriculture Equalization Fund (GOAEF) .

Growth characters : At bunch shooting stage, (fourteen months after cultivation) the following growth characteristics were recorded in each season: pseudostem height (cm) was measured from the soil surface up to the petiole of the last emerged leaf , pseudostem circumference (cm) was

measured at height of 20 cm above soil surface, number of green leaves per plant as well as leaf area (m^2) of the third leaf from the top was calculated as described by Murry (1960) .

Leaf chemical constituents : From each treatment, a 10 cm^2 from the third leaf from the top of the plant in each individual plant at bunch shooting stage was taken as recommended by Hewitt (1955) .Total nitrogen was determined by Micro-Kjeldahle method as described by Jackson (1973) ,Phosphorus was determined according to the method of Chapman and pratt (1961) and K was determined by using the Atomic Absorption Spectrometer (Per Kin – Elemer, Model 3300)according to the methods described by Chapman and Pratt (1961).

Yield characteristics: At harvest date (beginning at the first week of January) when the top of hands have turned slightly yellow, samples from each treatment were collected and the following characteristics, i.e. bunch weight (kg), bunch length (cm), number of hands per bunch and number of fingers per hand were recorded.

Fruit physical and chemical characteristics :After artificial ripening of bunch, fruit sample was taken and the following physical characteristics were determined; finger length (cm),finger weight (g), pulp weight (g), peel weight (g) and percentage of pulp per finger. Total sugar and starch concentrations in fruits were determined by using phenol sulphuric acid method as described by Dubois *et al.* (1956). Soluble solids content in fruits were determined by using hand rafractometer. Nitrate concentration was determined by using salicylic acid method as described by Cataldo *et al.* (1975).

Statistical analysis: The experimental data were tabulated and statistically analyzed according to Snedecor and Cochran (1980) and the differences between mean various treatments were compared by using L.S.D. at 5% level of probability .

It is worthy to mention here that all organic manures treatments whether with or without biofertilizers mixture were only fertilized with 50% NPK mineral fertilizers.

RESULTS AND DISCUSSION

Vegetative growth: The effect of using organic manures fertilization, i.e. cattle or town refuse at different rate levels with or without biofertilizers mixture in combination with 50% mineralized NPK on pseudostem height and circumference , leaf area as well as number of green leaves during inflorescences emergence of Grand Nain banana plant in comparison with control plants only fertilized with 100% NPK are presented in Table (3).

Regarding cattle manures at the rate of 75 and 100% showed a significant increase in pseudostem height and leaf area. Although , all the studied rates of cattle manure induce a significant increase in pseudostem circumference during both seasons yet, 100% only cattle manure in the second one, since in showed a significant increase in number of green leaves comparing with control. Meanwhile, town refuse manure at different rates did not present any effect on pseudostem height and number of green leaves during both seasons. Whereas, pseudostem circumference at the rate of

100% town refuse as well as 75 and 100% in first and second seasons, respectively produced significant increase , but the rate of 75 as well as 100% induced significant increase in leaf area during both seasons comparing with the control.

Regarding addition of biofertilizers mixture with either cattle or town refuse, it was noticed that, both organic manures did not induce an obvious trend on pseudostem height during the both seasons. However, in the second one inoculation of banana plants with biofertilizers mixture produced significant increase in pseudostem height of 50 and 75% cattle and 100% town refuse. Also, results indicated that both organic manures in both seasons induced an increase in pseudostem circumference and leaf area as compared with control except of the rate of 50% of either cattle or town refuse of pseudostem circumference and the rate of 50 % of town refuse for leaf area which were not affected during the second season. The results indicated that number of green leaves were significantly increased in first season for either cattle or town refuse at the rate of 100% comparing with the control or other studied treatments In the second season, inoculation with biofertilizers mixture had a significant increase on number of green leaves of 75 and 100 % of both cattle and town refuse manures comparing with their counterparts non- inoculated or control plants

Generally, highest values of pseudostem height and circumference as well as leaf area were recorded by inoculated cattle manure at the rate of 100 and 75 % in first and second season , respectively comparing with the other studied treatments or control. Meanwhile, the highest number of green leaves were recorded by inoculated either cattle or town refuse at the rate of 100% in both seasons comparing with the other studied treatments or control (100%NPK). The positive effects of organic fertilizers could be attributed to their improvement effect on physical, chemical and biological properties of the soil which might enhance plant nutrients uptake . The variation between different organic sources might be due to variation in the rate of the decomposition, humus substance production as well as to the released nutrients to the growing plants . The role of the biofertilizer could be attributed to the role of N-fixing bacteria in supplying the soil and plants by the available nitrogen to be absorbed and metabolized by the plant. Similar results were obtained by Jeeva *et al.* (1988), Abd El Aziz (2002). Abd- El moniem and Radwan (2003), Gogoi *et al. (* 2004) and Mai *et al.* (2005) on banana plants. In these respect, Martin *et al.* (1989) reported that recycling of organic wastes with biofertilizers instead of mineral fertilization could minimize the environmental pollution to a great extent

Leaf chemical constituents: Data in Table (4) indicated that both organic manures in first season did not show any significant differences on nitrogen concentration. Meanwhile, in second season 100% cattle as well as 75 and 100% town refuse induced significant increase. No differences in P concentration could be noticed in leaf of banana plants which fertilized with either cattle or town refuse manure at different rates as compared with the control in both seasons . Fertilized banana plants with either organic manure, cattle manure or town refuse at different rates produced a significant increases in K concentration of leaves in both seasons except of 50% cattle

in first season and 50 % town refuse in both seasons as compared to control treatment .

Concerning the addition of biofertilizers mixture with either cattle or town refuse, it was noticed in both seasons that both organic manures produced significant increases in leaf N concentration of 75 and 100% of cattle manure as well as in all levels of town refuse . Moreover, both organic manures induced a significant increases in P and K concentrations comparing with their non- inoculated counterparts or with the control.

Generally, the highest values of N, P and K concentrations in banana leaf were recorded in both seasons by cattle manure at the rate of 100 % inoculated with biofertilizers mixture as compared to the other treatments. Adding chemical fertilizers particularly NPK to the organic manure could enhance chemical activities within organic manure and promote N, P and K releasing thereby increase these elements in rooting zone, consequently increasing their absorption by the plant.

Table (3): Effect of mineral and bio-organic fertilization on pseudostem height (cm) and circumference (cm), leaf area (m^2) as well as number of green leaves during inflorescence emergence of Grand Nain banana plants First season (2004 / 2005)

Treatment	pseudostem		leaf area	no. of green leaves
	height	circumference		
1-100% NPK (control)	270.00 CDE	85.67 E	1.42 F	12.33 ABC
2- 50% NPK +Cattle 50%	266.67 DE	89.67 C	1.43 F	12.00 C
3- 50% NPK +Cattle 75%	286.67AB	90.67 B	1.67 CD	12.67 ABC
4- 50% NPK +Cattle 100%	286.67AB	91.33 A	1.75 BC	13.00 AB
5- 50% NPK +Cattle 50%+biofertilizer	276.67 BCD	89.67 C	1.63 DE	12.67 ABC
6- 50% NPK +Cattle 75% +biofertilizer	286.67AB	89.67 BC	1.81 AB	13.00 AB
7- 50% NPK +Cattle 100%+biofertilizer	290.00 A	91.67A	1.92 A	13.33 A
8- 50% NPK +Town 50%	260.00 E	85.67 E	1.53 EF	12.00 C
9- 50% NPK +Town 75%	270.00 CDE	85.33 E	1.75 B	12.67 ABC
10- 50% NPK +Town 100%	280.00ABC	90.00 C	1.83 AB	13.00 AB
11- 50% NPK +Town 50%+biofertilizer	263.33 E	86.33 D	1.57 DE	12.67 ABC
12- 50% NPK +Town 75% +biofertilizer	283.33AB	91.33A	1.83 AB	13.00 A
13- 50% NPK +Town 100%+biofertilizer	286.67 AB	91.33 A	1.87 A	13.33 A
LSD at 0.05	12.48	0.53	0.11	0.99
Second season (2005 / 2006)				
1-100% NPK (control)	255.00 F	84.33 F	1.49E	12.00 C
2- 50% NPK +Cattle 50%	245.33 F	87.67 D	1.57E	12.33 BC
3- 50% NPK +Cattle 75%	276.33 D	90.33 CB	1.67 D	12.33 BC
4- 50% NPK +Cattle 100%	300.67 B	91.00 B	1.67 D	13.00 AB
5- 50% NPK +Cattle 50%+biofertilizer	276.33 E	86.33 E	1.72 CD	12.67 BC
6- 50% NPK +Cattle 75% +biofertilizer	310.33 A	92.67 A	1.9 A	13.00 AB
7- 50% NPK +Cattle 100%+biofertilizer	291.00 C	91.67 A	1.72 CD	13.67 A
8- 50% NPK +Town 50%	254.00 F	83.33 F	1.53 E	12.33 BC
9- 50% NPK +Town 75%	266.00 EF	88.33 D	1.71 CD	12.33 BC
10- 50% NPK +Town 100%	250.33 F	85.67 E	1.81B	12.33 BC
11- 50% NPK +Town 50%+biofertilizer	250.00 F	83.67 F	1.56 E	12.67 BC
12- 50% NPK +Town 75% +biofertilizer	258.67 F	89.67 C	1.78 BC	13.00 AB
13- 50% NPK +Town 100%+biofertilizer	285.67 C	92.33 A	1.85 AB	13.67 A
LSD at 0.05	9.001	1.21	0.08	0.93

Table (4) : Effect of mineral and bio-organic fertilization on nitrogen (%), phosphorus(%) and potassium (%) in leaves during inflorescence emergence of Grand Nain banana plants . First season (2004 / 2005)

Treatment	N (%)	P (%)	K (%))
1-100% NPK (control)	2.87 DEF	0.410 B	3.133 E
2- 50% NPK +Cattle 50%	2.60 G	0.413 B	3.133 E
3- 50% NPK +Cattle 75%	2.80 F	0.410 B	3.276 D
4- 50% NPK +Cattle 100%	2.83 EF	0.413 B	3.800 C
5- 50% NPK +Cattle 50%+biofertilizer	2.92 ED	0.420 A	3.900 B
6- 50% NPK +Cattle 75% +biofertilizer	3.12 C	0.421 A	3.950 B
7- 50% NPK +Cattle 100%+biofertilizer	3.52 A	0.423 A	3.933 B
8- 50% NPK +Town 50%	2.85 DEF	0.413 B	2.750 F
9- 50% NPK +Town 75%	2.90 DE	0.412 B	3.730 C
10- 50% NPK +Town 100%	2.92 D	0.410 B	3.800 C
11- 50% NPK +Town 50%+biofertilizer	3.13 C	0.420 A	3.900 B
12- 50% NPK +Town 75% +biofertilizer	3.11 C	0.420 A	3.916 B
13- 50% NPK +Town 100%+biofertilizer	3.31 B	0.423 A	4.166 A
LSD at 0.5	0.081	0.006	0.09
Second season (2005 /2006)			
1-100% NPK (control)	2.80 G	0.416 B	3.166 E
2- 50% NPK +Cattle 50%	2.60 H	0.415 B	3.733 C
3- 50% NPK +Cattle 75%	2.65 H	0.414 B	3.866 B
4- 50% NPK +Cattle 100%	3.14 DE	0.413 B	3.900 B
5- 50% NPK +Cattle 50%+biofertilizer	2.82 G	0.425 A	4.016 AB
6- 50% NPK +Cattle 75% +biofertilizer	3.22 C	0.428 A	4.0083 A
7- 50% NPK +Cattle 100%+biofertilizer	3.38 A	0.430 A	4.100 A
8- 50% NPK +Town 50%	2.75 G	0.410 B	2.963 F
9- 50% NPK +Town 75%	2.90 F	0.413 B	3.280 D
10- 50% NPK +Town 100%	3.13 E	0.413 B	3.883 B
11- 50% NPK +Town 50%+biofertilizer	3.21 CD	0.424 A	3.913 B
12- 50% NPK +Town 75% +biofertilizer	3.30 B	0.426 A	4.083 A
13- 50% NPK +Town 100%+biofertilizer	3.31 AB	0.429 A	4.100 A
LSD at 0.5	0.071	0.007	0.107

The concentration of NPK in the root zone increased which encouraged NPK absorption and consequently its accumulation in leaves. The enhancing effect of biofertilizer on increasing P concentration could be attributed to the beneficial effect of *Azotobacter, Azospirillum* or phosphorus dissolving bacteria on secreting organic acids which could release the bound phosphorus in available from for plants . These results are in harmony with finding of Lyengar *et al.* (1984), Abou- Aziz *et al. (*1993), El –Demerdash *et al.* (1995), Abd El Naby (2000), Abd El Aziz (2002) and Saad and Saad (2007) on banana plants.

Yield and its components : The response of bunch weight and length, number of hands per bunch as well as number of fingers per bunch at maturity stage of Grand Nain banana plants to fertilization with two different sources of organic manures, i.e. cattle and town refuse with or without biofertilizers mixture in combination with 50% mineralized NPK in comparison

with control plants only fertilized with 100% NPK are shown in Table (5). significant increase in pulp percentage of banana fruit as compared to control treatment (100% NPK).

Table (5) : Effect of mineral and bio-organic fertilization on bunch height (cm) and weight (kg), number of hands/bunch as well as number of fingers/bunch at maturation stage of Grand Nain banana plants.

Treatment	bunch		number of hand/bunch	number of finger/bunch
	length	weight		
First season (2004 / 2005)				
1-100% NPK (control)	91.00 gh	22.06 h	10.33 ef	184.00h
2- 50% NPK +Cattle 50%	92.00gh	23.60 g	10.00 f	192.67 fg
3- 50% NPK +Cattle 75%	95.33 fg	25.53 ef	10.66 def	193.33 fg
4- 50% NPK +Cattle 100%	100.67 de	26.76 cd	11.33 bcd	201.33 de
5- 50% NPK +Cattle 50%+biofertilizer	104.33 bcd	24.56 fg	11.66 bc	215.33 c
6- 50% NPK +Cattle 75% +biofertilizer	108.33 ab	27.03 cd	11.66 bc	216.00 bc
7- 50% NPK +Cattle 100%+biofertilizer	111.66 a	29.80 a	13.00 a	229.33 a
8- 50% NPK +Town 50%	89.00 h	23.66 g	10.00 f	190.33 g
9- 50% NPK +Town 75%	94.00 fg	25.46 ef	10.33 ef	191.67 g
10- 50% NPK +Town 100%	98.33 ef	28.83 ab	11.00 cde	198.67 ef
11- 50% NPK +Town 50%+biofertilizer	101.67 cde	26.40 de	11.33 bcd	206.33 d
12- 50% NPK +Town 75% +biofertilizer	105.66 bc	27.03 cd	11.66 bc	220.67 bc
13- 50% NPK +Town 100%+biofertilizer	106.33 bc	28.66 b	12.33 ab	221.67 b
LSD at 0.05	5.20	1.18	0.08	6.22
Second season (2005 / 2006)				
1-100% NPK (control)	91.66 h	22.37 g	10.33 ef	181.67 h
2- 50% NPK +Cattle 50%	92.00 gh	24.53 f	10.33 ef	192.00 fg
3- 50% NPK +Cattle 75%	96.33 fg	26.83 cde	10.33 ef	215.33 d
4- 50% NPK +Cattle 100%	101.67 de	29.10 ab	11.33 cd	219.67 cd
5- 50% NPK +Cattle 50%+biofertilizer	104.33 cd	25.46 ef	11.33 cd	224.00 c
6- 50% NPK +Cattle 75% +biofertilizer	109.33 b	27.83 bc	12.00 bc	242.67 b
7- 50% NPK +Cattle 100%+biofertilizer	114.67 a	29.90 a	13.00 a	251.00 a
8- 50% NPK +Town 50%	93.66 gh	24.46 f	10.00 f	190.00 g
9- 50% NPK +Town 75%	94.66 fgh	25.26 f	10.33 ef	200.00 ef
10- 50% NPK +Town 100%	98.33 ef	27.36 cd	11.00 de	204.67 e
11- 50% NPK +Town 50%+biofertilizer	102.33 de	26.00 def	11.33 cd	215.33 c
12- 50% NPK +Town 75% +biofertilizer	107.33 bc	27.66 bc	11.66 bcd	224.67 c
13- 50% NPK +Town 100%+biofertilizer	111.33 ab	29.90 a	12.33 ab	240.67 b
LSD at 0.05	4.41	1.56	0.08	8.31

Regarding the effect of organic manures, the data indicated that both organic manures induced a significant increase in bunch length as compared to control except of the rate of 50% town refuse at second season . Weights of banana bunch were significantly increased when fertilized with both organic manures comparing with the control (100% NPK). Banana plants with cattle manure at the rate of 100% significantly produced an increase in number of hands per bunch in both seasons as compared to the control (100% NPK). Moreover, increasing the rate of either cattle or town refuse manure positively affected bunch weight and length, number of hands per bunch as well as number of fingers per bunch in both seasons.

Biofertilizers mixture with either cattle or town refuse manures induce an increase in bunch weight and length, number of hands per bunch as well as number of fingers per bunch of banana plants comparing with other counterparts non inoculated or control . In general, cattle manure at the rate of 100% plus inoculation recorded the highest value of bunch length as compared with other treatments . Enhancing weight of bunch as well as hand weight might be due to the beneficial effects of organic N fertilizers on growth characters and nutritional status of the plants in favor of maintaining good balance between growth and fruiting behavior. The favorable effect of biofertilizers could be attributed to its enhancing effect on plant growth parameters which in turn, could be reflected on banana yield. The great benefits of the combination between organic and bio- fertilization on yield was emphasized by Smith (1998), Chezhiyan *et al.*(1999), El- Kafrawy (2005) and Merwad (2007) on banana plants.

Fruit quality:

Data in Table (6) showed the effects of fertilization by organic manures, i.e. cattle or town refuse manure at different rates with or without biofertilizers mixture in combination with 50% mineralized NPK on fruit weight and length, pulp and peel weight as well as pulp percentage during maturity stage of Grand Nain banana plants in comparison with control plants only fertilized with 100% NPK . Both organic manures produced significant increase in fruit length as compared with control treatment (100% NPK) except of cattle at the rate of 50% and town refuse at both 50 and 75 % during the first season. Both organic manures in the first season did not show any significant differences in fruit weight, except of cattle manure at the rate of 100%. Meanwhile, in the second season both cattle and town refuse manures at different rates produced significant increment in fruit weight comparing with control except of town refuse at the rate of 50% which was not affected . In addition, either cattle or town refuse manure at the rate of 100% in the first season produced significant increase in pulp weight of banana plants comparing with the control . Meanwhile, in the second season, both organic manures at different rates induced an increment in pulp weight as compared to control. Moreover, adding either source of organic manures to banana plants at all different rates reduced the peel weight, except of cattle manure at rate of 100 % in the second season which induced significant higher value as compared to control . Both organic manures, i.e. cattle or town refuse at different rates in both seasons produced

With respect to the inoculation of biofertilizers mixture with either cattle or town refuse manure, it was noticed in both seasons that both organic manures induced a significant increase in fruit length, pulp weight and percentage comparing with the non- inoculated or control. Meanwhile, cattle or town refuse manure in by mixture, biofertilizers increased in fruit weight and peel weight as compared with counterparts non-inoculated or control treatment except of town refuse at the rate of 50% in the first season which was not affected . In general, cattle manure at the rate of 100% plus biofertilizers mixture recorded the highest values of peel weight in both seasons comparing with the other studied or control.

The positive effects of biofertilizers mixture on the quality of fruits could be attributed to their effect on improving chemical and physical properties of the soil. These results are in accordance with those reported by Abd El-Aziz (2002), El-Shenawi and El-Sayed (2005), El-Kafrawy(2005) and Merwad (2007) on banana plants

Table (6) : Effect of mineral and bio-organic fertilization on fruit weight and length, pulp and peel weight as well as pulp percentage at maturity stage of Grand Nain banana plants .

Treatment	fruit		Pulp weight (g)	Peel weight (g)	Pulp %
	length (cm)	weight (g)			
First season (2004 / 2005)					
1-100% NPK (control)	17.49 f	95.33 e	62.33 g	33.00 cd	65.38 h
2- 50% NPK +Cattle 50%	17.71 f	96.66 e	65.67 fg	30.99 de	67.79 d
3- 50% NPK +Cattle 75%	18.17 e	98.66 e	67.64 efg	31.02 de	68.55 c
4- 50% NPK +Cattle 100%	19.36 c	106.67 cd	73.15 bcd	33.52 c	68.57 c
5- 50% NPK +Cattle 50%+biofertilizer	19.50 bc	114.00 ab	76.76 ab	37.24 b	67.33 de
6- 50% NPK +Cattle 75% +biofertilizer	19.70 ab	117.00 ab	79.32 a	37.68 b	67.79 d
7- 50% NPK +Cattle 100%+biofertilizer	19.88 a	120.33 a	80.13 a	40.20 a	66.59 fg
8- 50% NPK +Town 50%	17.56 f	96.00 e	64.56 fg	31.44 cde	67.25 de
9- 50% NPK +Town 75%	17.76 f	96.33 e	63.89 g	32.44 cd	66.32 g
10- 50% NPK +Town 100%	18.56 d	99.33 e	69.71 de	29.62 ef	70.18 b
11- 50% NPK +Town 50%+biofertilizer	19.25 c	101.00 de	72.13 cd	28.87 f	71.42 a
12- 50% NPK +Town 75% +biofertilizer	19.67 ab	111.00bc	74.32 bc	36.68 b	66.95 ef
13- 50% NPK +Town 100%+biofertilizer	19.76 ab	118.67 a	78.61 a	40.06 a	66.24 g
LSD at 0.05	0.29	7.08	3.55	2.09	0.59
Second season (2005 / 2006)					
1-100% NPK (control)	16.96 f	93.660 f	59.31 f	34.35 e	63.32 i
2- 50% NPK +Cattle 50%	18.67 e	101.00 e	69.14 e	31.86 f	68.46 a
3- 50% NPK +Cattle 75%	18.97 de	102.33 e	69.89 de	32.44 ef	68.29 ab
4- 50% NPK +Cattle 100%	19.36 bcd	112.33 cd	73.57 cd	38.76 cd	64.49 h
5- 50% NPK +Cattle 50%+biofertilizer	19.50 abc	113.33 cd	75.32 c	38.01 cd	66.46 ef
6- 50% NPK +Cattle 75% +biofertilizer	19.70 abc	117.00 bc	77.43 bc	39.57 bc	66.18 f
7- 50% NPK +Cattle 100%+biofertilizer	19.97 a	125.67 a	82.13 a	43.54 a	65.35 g
8- 50% NPK +Town 50%	18.67 e	100.00 ef	67.7 e	32.30 ef	67.70 c
9- 50% NPK +Town 75%	18.67 e	101.00 e	68.56 e	32.44 ef	67.88 bc
10- 50% NPK +Town 100%	19.27 cd	108.00 de	73.76 cd	34.24 e	68.29 ab
11- 50% NPK +Town 50%+biofertilizer	19.56 abc	110.67 d	73.96 c	36.70 d	66.87 de
12- 50% NPK +Town 75% +biofertilizer	19.77 ab	112.67 cd	75.61 c	37.06 d	67.11 d
13- 50% NPK +Town 100%+biofertilizer	19.86 a	121.33 ab	81.13 ab	40.20 b	66.87 de
LSD at 0.05	0.49	6.37	4.01	2.15	0.42

Chemical analysis of banana fruits, i.e. total soluble solids (T.S.S.), total sugar, starch and nitrate concentrations at ripening stage are presented in Table (7). Fertilized banana plants by either cattle or town refuse manure produced significant increase in total soluble solids and total sugar concentration in banana fruits of both seasons as compared to control (100% NPK), except of town refuse at the rate of 50% for T.S.S. which was not affected. On the other hand, both organic manures showed lower values of starch concentration in banana fruits when compared with control plants. Whereas both manures did not show any significant increase in nitrate concentration of fruits in both seasons except the rate of 100 % town refuse

which induced significant higher value of nitrate concentration comparing with their counterparts or control.

Regarding the inoculation with biofertilizers mixture, it was noticed in both seasons that both organic manures produced an obvious increase in fruit T.S.S.% and total sugar as compared to the counterparts non inoculated or control. On the other hand, inoculation of biofertilizers mixture with organic manures in both seasons, decreased starch and nitrate concentrations of banana fruits . In general, the highest values of T.S.S. and total sugar concentrations of banana fruits were recorded by the rate of 100% cattle manure plus biofertilizers mixture in both seasons.

Table (7) : Effect of mineral and bio-organic fertilization on fruit T.S.S., total sugar, starch concentration and nitrate concentration at ripening stage of Grand Nain banana plants .

Treatment	T.S.S	total sugar %	Starch %	Nitrate mg/g F.W.
First season (2004 / 2005)				
1-100% NPK (control)	19.46 h	16.22 f	2.83 a	0.308 b
2- 50% NPK +Cattle 50%	20.06 fg	17.73 e	2.60 c	0.293 e
3- 50% NPK +Cattle 75%	20.26 ef	18.63 d	2.27 bc	0.294 e
4- 50% NPK +Cattle 100%	20.60 e	18.77 d	2.21 c	0.300 cd
5- 50% NPK +Cattle 50%+biofertilizer	21.40 d	19.7 bc	2.31 b	0.290 f
6- 50% NPK +Cattle 75% +biofertilizer	21.80 bc	20.07 ab	2.07 d	0.291 e
7- 50% NPK +Cattle 100%+biofertilizer	22.50 a	20.1 a	2.06 d	0.292 e
8- 50% NPK +Town 50%	19.90 g	17.37 e	2.29 b	0.300 cd
9- 50% NPK +Town 75%	20.20 fg	17.56 e	2.24 bc	0.303 b
10- 50% NPK +Town 100%	20.40 ef	17.70 e	2.21 c	0.321 a
11- 50% NPK +Town 50%+biofertilizer	21.30 d	18.83 d	2.11 d	0.297 cde
12- 50% NPK +Town 75% +biofertilizer	21.50 cd	19.5 c	2.11 d	0.295 de
13- 50% NPK +Town 100%+biofertilizer	22.00 b	19.9 abc	2.09 d	0.293 e
LSD at 0.05	0.35	0.43	0.075	0.006
Second season (2005 / 2006)				
1-100% NPK (control)	19.03 f	16.22 h	2.81 a	0.309 b
2- 50% NPK +Cattle 50%	19.56e	18.45 e	2.56 c	0.290 f
3- 50% NPK +Cattle 75%	19.60 e	18.40 e	2.48 cd	0.291 e
4- 50% NPK +Cattle 100%	19.69 d	18.96 d	2.26 e	0.292 e
5- 50% NPK +Cattle 50%+biofertilizer	20.30 c	19.63 bc	2.13 fg	0.292 d
6- 50% NPK +Cattle 75% +biofertilizer	20.33 c	19.64 bc	2.11 g	0.292 d
7- 50% NPK +Cattle 100%+biofertilizer	21.30 a	20.32 a	2.10 g	0.293 d
8- 50% NPK +Town 50%	19.06 f	17.18 g	2.17 b	0.296 cd
9- 50% NPK +Town 75%	19.93 d	17.51 fg	2.55 c	0.298 c
10- 50% NPK +Town 100%	20.06 cd	17.76 f	2.45 d	0.332 a
11- 50% NPK +Town 50%+biofertilizer	20.1 c	19.23 cd	2.23 e	0.2934cd
12- 50% NPK +Town 75% +biofertilizer	21.26 b	19.34 bcd	2.21 ef	0.2934cd
13- 50% NPK +Town 100%+biofertilizer	21.83 b	19.83 ab	2.18 efg	0.296 cd
LSD at 0.05	0.29	0.50	0.083	0.005

Hammam (2003) mentioned that using N via mineral source and N-fixing bacteria was significantly favored in improving fruit quality of Williams and Cavendish banana in terms of increasing the T.S.S. and total sugar as well as decreasing the percentages of starch and total acidity as compared to completely N mineral source. In this respect, the effect of biofertilizer and

NPK on increasing the T.S.S. and total sugar as well as decreasing the percentage of starch concentration in the pulp of fingers could be due to their enhancement effect on plant total leaf area which could reflect on more carbohydrates production through photosynthesis process. These results are in agreement with those reported by Tiwary *et al.* (1998), Abd El-Moniem and Radwan (2003), Gogoi *et al.* (2004), El-Kafrawy (2005) and Merwad (2007) on banana.

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تأثير التسميد الكيماوي والعضوي والحيوي علي النمـــو والمحـــصول والـــصفات الكيماوية لنبات الموز

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أجريت هذه الدراسة خلال موسمي ٢٠٠٤ – ٢٠٠٥ لدراسة تأثير استخدام نوعين من الأســمدة العضوية وهي سماد مخلفات المدن وسماد مخلفات الماشية وذلك تحت ثلاث مستويات مختلفة وهـــي ٥٠ ، ٧٥ ، ١٠٠ % من المعدل الموصي به وذلك في وجود الـــسماد الحيـــوي المكـــون مـــن الميكـــروبين والفوسفورين وذلك تحت مستوي ٥٠% من التسميد المعدني الكيماوي(NPK) الموصي به وذلـــك علـــي صفات النمو والتركيب الكيماوي والمحصول وصفات الجودة لثمار الموز صنف جراندنان وذلك بالمقارنـــة مع نباتات الكونترول التي تم تسميدها فقط بمعدل ١٠٠% من التسميد المعـــدني (NPK) الموصـــي بـــه وكانت النتائج المتحصل عليها كما يلي:-

كانت أفضل النتائج هي التسميد بسماد مخلفات الماشية بمعدل ١٠٠% في وجود السماد الحيوي وذلك بالمقارنة بجميع المعاملات والكنترول . لوحظ ايضا ان إضافة السماد الحيوي إلى الـــسماد العـــضوي أدى إلى تحسين كثير من صفات النمو والتركيب الكيماوي للاوراق والمحصول وصـــفات الجـــودة لثمـــار الموز . كما وجد ان زيادة معدلات التسميد العضوي في وجود السماد الحيوي قد أعطت نتيجـــة إيجابيـــة لجميع المعاملات وخاصة مع المعدل العالي من التسميد العضوي . وجد ايـــضا ان التركيـــب الكيمـــاوي لاوراق لنبات الموز قد أعطت نتيجة افضل عند استخدام مصدر النتروجين العضوي بجانـــب الكيمـــاوي بالمقارنة بالكيماوي فقط . وقد وجد ايضا ان التسميد العضوي بسماد مخلفات الماشية اومخلفات المدن كانت له ايجابية محببة او مفضلة علي كثير من صفات الجودة مثل زيادة وزن الاصبع وزيادة كل مـــن المـــواد الصلبة الذائبة الكلية والسكريات الكلية كما أدي ايضا إلى خفض تركيز كل من النشا والنترات ما عدا عند استخدام التركيز المرتفع من سماد مخلفات المدن . وفي العموم قد وجد ان استخدام التسميد العضوي علـــي صورة سماد مخلفات الماشية بتركيز ١٠٠% قي وجود السماد الحيوي٥٠% من التسميد الكيماوي(NPK) قد اعطي افضل النتائج علي الصفات التي تمت دراستها .