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Partial Substitution of Chemical Fertilization of Banana (*Musa cavendishii* L.) Plants by Organic Stimulators

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ABSTRACT

Effects of organic fertilizer (compost) and/or humic acid as a stimulators on minimizing mineral nutrition rate were evaluated in order to decreasing the environmental pollution and high cost of banana production. Field experiments were carried out during two growing seasons (2014/2015and2015/2016) at wadi El-Natrun, Nubaria region, El-Behera Governorate, Egypt on Grand Naine cultivar grown in sandy soil and the irrigation was pumped from a well fresh water (1.18 dSm^{-1}). The data indicated that application of compost with or without humic acid minimizing the recommended values of mineral fertilization used for banana production to about 50% without affecting on its productivity. Using 50 ton compost with spraying banana plant (Grand Naine cv) three times on the middle of April, May and June by humic acid at 1500 ppm gave best results with regard to growth, flowering and maturity as well as productivity. These recommended treatments stimulated all studied growth parameters as well as recorded earliness flowering and maturity. In addition it increased, bunch weight and total yield as well as improved physical and chemical characters of the fruits in relative to the control.

Keywords: Organic stimulators, compost, mineral fertilizers, humic acid, banana (*Musa cavendishii* L.) grandnaine cv.

INTRODUCTION

In Egypt, sandy soil represents the most desert area and they usually deficient in plant nutrients and organic matters content. Banana (*Musa cavendishii* L.) needs and consumed large amount of fertilizers from a limited soil depth, especially N and K, due to its shallow root system (Amin, *et al*, 2016). Fertilization is one of the most important factor which limiting growth and productivity in banana like all economical plant species. The high cost of intensive use of only chemical fertilizers to achieve high production of banana facing major problem for growers. In addition, many problems of environmental pollution have resulted from the excessive application of mineral fertilizers in the traditional farming system is likely to be further limit the application of nitrogen to rangeland. So, chemical fertilizers are considered as environmental pollutant agent during their producing and utilization. Moreover, due to nitrogen ability to leaching into soil which transferred through the plant to the human, nitrate causes serious diseases (Dillard and German, 2000).

Unconventional methods are used to minimize the huge amount of applied chemical fertilizers in order to reduce both environmental pollution and high cost of agricultural production. Many investigations suggested that organic fertilizers, especially in sandy soil, increase soil organic matter, colloidal system, nutrients availability for plant growth as well as improve soil properties physically, chemically and biologically (Talha, 2013). Using natural and safety fertilizers which are rich sources of available nutrients and phytohormouns has been suggested in order to improve plant growth (Antoun *et al* 2010). One of the possible options to reduce the use of chemical fertilizers could be recycling of organic wastes. Compost as organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients. Compost is a natural way to rejuvenate and feed the soil. It is rich in the percentage of organic matter, organic acid as well as major nutrients (N,P and K) and phytohormons (Turrion *et al* 2012). Moreover, it recycles nutrient elements by feeding the microorganisms that live there (Jothimani *et al* 2013).

On the other hand, it was reported that the combination of compost with N-fertilizers enhanced the biomass and yield of different plant species (Antoun *et al,* 2010) in addition to reduce sources of environmental pollution and maintain human health. Similarly, humic acid is highly effective in nutrients availability and promote growth of many plant species (Amin, *et al*, 2016). It also increases yield and resistant ability of many crops to the unfavorable condition (EL-Shenawi *et al*, 2015). Humate being organic and biodegradable nature is considered as an important source of nutrient for sustainable (Khaled and Fawy 2011) agriculture. It contains various trace elements (Fe, B, Cu, Zn, Co, Mo and Cl-), vitamins, amino acids and plant growth substances (IAA, IBA, Cytokinins and ABA) which cause many beneficial effects on plant growth and development (Amin, *et al*, 2016). Baiea and EL-Gioushy (2015) reported that humic acid from leonardite (a naturally occurring highly compressed and decomposed, soft brown and coal-like organic material, usually found in conjunction with deposit of lignite) exhibits auxin-like effects. The stimulation of humic acid as a biostimulats on plant growth may be due to its stimulation effects on biosyntheses of α- tocopherol (vitamin-E), ascorbic acid, carotenoids in the chloroplasts which protect photosynthetic apparent of PSII (Zhang and Schmidt, 2000). Damir *et al*, (2004) found that humic acid improving leaf water status, some nutrients uptake, pulling growth and strength due to humate. Schmidt (2005) demonstrated that biostimulats seaweed extract and humic acid increased plants growth and productivity especially under stress condition due to their promoting effects on biosynthes of endogenous auxins and cytokinins altering hormonal balance within the plant tissue. The auther added that humate enhanced antioxidants within the plant tissue for protection against unfavorable condition, increasing water status, some nutrients uptake pulling plant growth and productivity.

This study aimed to minimize the huge amount of chemical fertilizers used for banana (*Musa cavendishii* L.) Grand Naine production grown in sandy soil by using compost and humic acid. The effect of these organic stimulators on growth, flowering, certain chemical composition and banana productivity were evaluated.

MATERIALS AND METHODS

Field experiments were carried out during the two growing seasons of 2014/2015 and 2015/2016 in a private orchard situated at Wadi El-Natrun, Nubaria region, El-Behera Governorate, Egypt. Nubaria region is situated at 30°38'00.4" N latitude, 30°3'35.9" E longitude and the altitude is 28m above the sea level.

Soil samples were collected from two successive depth (0-30 and 30-60 cm) before cultivation, analyzed physically and chemically according to Jacksone (1967) and the data are presented in Table 1

Table 1. Certain physical and chemical properties of the soil used

a- Physical traits

Soil depth (cm)	Mechanical analysis %				Texture	Bulk density g/cm	Moisture content by volume %	
	Sand		Silt	Clay			Field capacity%	Wilting point
	Fine	Coarse						
0-30	46.2	48.8	3.3	1.7	Sandy	1.7	14	4.9
30-60	48	45.8	4.2	2	soil	1.59	13	5.5

b- Chemical traits

Soil depth (cm)	EC (dSm^{-1}) (1:5 extract)	pH (1:5 extract)	Organic matter %	CaCO3 %	Available %			Anions meq/ l				Cations meq/ l			
					N	P	K	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
0-30	1.15	8.11	0.75	1.6	9.7	0.18	0.27	0.0	1.13	2.61	10.9	6.31	2.27	5.46	0.60
30-60	2,45	8.323	1.0	1.6	10.0	0.20	0.19	0.0	1.15	2.51	11.3	6.27	2.25	5.69	0.75

First and second ratoon of banana (*Musa* sp.) Grand Naine cv were selected on the 1st week in March of both seasons at 3.5x3.5m apart similar as far as possible. Experimental plants received the normal horticulture practices as recommended by Agric. Res. Cent. (ARC) Ministry of Agric., Egypt except for the purpose of the study. To evaluate the response of Grand Naine banana plants to organic and chemical fertilizers, a split plot design system with three replication was used. Each replicate contain three plants. The treatments included a combination among different doses of compost and minerals (NPK) fertilizers as well as humic acid. The main plot was employed by the fertilizers doses whereas the sub plots were devoted to humate. The three NPK doses examined were the recommended NPK doses (RD), 75% and 50% from the RD (800+100+1000 N, P_2O_5 and K_2O actual g/ plant in the form of ammonium nitrate 33.6%N, phosphoric acid 80% and potassium sulphate 48%K_2O respectively. For each season, The NPK doses were added during the period from the first week of March to October with the irrigation water system. The compost as an organic fertilizers (0, 25 and 50ton/feddan) were randomly distributed in the main plots and added to the experiments during preparation the soil before planting. The compost used was analyzed chemically according to A.O.A.C (1970) and the data are given in Table 2.

Table 2. Certain chemical analysis of the compost used (1:5 extract)

weight of m3(kg)	Moisture %	pH	EC (dSm-1)	O.M %	Organic carbon%	Ash %	C/N ratio	Total N%	Total P%	Total K%	Weed seed	Nematoda
680	16.6	7.8	1.46	31	17.5	69	01:17	1.03	1.25	1.34	Not found	not found

Three doses of Humic acid (Sigma company) denoted 0, 750 and 1500 ppm with 0.05% tween 20 as a surfactant were sprayed three times, 4 weeks intervals, till dripping. The 1st application was applied on the middle of April whereas the 2nd and 3rd ones were sprayed on May and June respectively. Spraying was took place before bunching by means of an atomizer sprayer.

Water irrigation used in this experiment was pumped from a well which analyzed chemically (Jakson, 1967) and the data are presented in the Table 3.

Table 3. Certain chemical characters of the pumped irrigation water

EC (dSm^{-1})	pH	Anions meq/ l				Cations meq/ l			
		CO3--	HCO3-	Cl-	SO4 --	Ca ++	Mg ++	Na +	K +
1.18	7.14	0.0	1.3	2.25	3.98	2.08	2.45	2.0	1.0

Data recorded:

1) Vegetative growth and flowering:

At bunch shooting stage, five samples were taken to recorded growth parameters including pseudostem height, circumference, leaf number, leaf area using the 3rd full expanded sized leaf from the plant tip according to Murry (1960) and using the following formula: Leaf area= length x width x 0.86

For flowering and maturation, the periods elapsed to bunch shooting stage and from flowering to harvesting in days were calculated.

2) Yield and fruit quality

The maturated bunches were harvested when the fingers reached to the full maturation stage in both seasons. Bunch weight, number of hands per bunch, number of finger per hand and average finger weight were estimated. Finger length and diameter as well as percentages of pulp/fruit peels, TSS, total acidity (g. malic acid/100g pulp) and total sugars (A.O.A.C, 2000) were also determined.

3) Chemical constituents

Certain chemical analyses were estimated in the 3rd full expanded leaf from the plant tip. These included concentrations of N, P and K (Chapman and Pratt, 1978) as well as photosynthetic pigments (Wettestein 1957).

Statistical analysis

Data were subjected to analysis of variance for factorial plot design in randomized complete blocks (Snedecor and Cochran 1980). Differences between treatments means were separated by the (New L.S.D) (Waller and Duncan 1969) least significant differences (LSD) test at a 0.05 probability level.

RESULTS AND DISCUSSION

Vegetative growth and earliness

Data in the Table 4 show that the 75 RD of NPK supplemented with 50 ton compost/feddan recoded highest values of pseudostem height and its circumference as well as number of leaves and leaf area compared with those of the other fertilization treatments. It was followed by supplementation of compost at 25 ton/ fedden to the 75%RD NPK. Similarly, 50% RD NPK+50 ton compost resulted in significant increase in all vegetative growth studied during the two growing seasons compared to the control. Similarly 50%RD+25ton compost showed insignificant increase in this respect. Therefore, treatment in which the plants received 75RD of NPK (450+75+600 g/plant) supplemented with 50 ton compost/feddan exhibited the highest vigor plants whereas the lowest values were scored by 50% RD+ 0 compost. These results are true during the two growing seasons. In this connection Loredana *et al*, (2015) who mentioned that growth vigor are greatly affected by soil treatment, efficiency as well as quantity and availability of nutrients.

As for the effect of humic acid treatment, data in the same table show that all growth parameter studied were increased compared to the control during the two growing seasons and the increase was a concentration dependent. However, there is no significant effects were detected between 750 and 1500 ppm Similarly all interaction treatments (fertilization x humic acid) increased height, circumference and number of leaves and leaf area of grandnaine banana plants grown during the two growing seasons. The most vigor plants were noticed with plants fertilized with 75%RD+50ton compost/feddan and sprayed with humic acid 1500ppm. The positive effect of humic are in agreements with those obtained on other plant species (Damir *et al*, 2004).

Table 4. Effect of different doses of NPK fertilizers,(RD) in the presence or absences of compost,(C) and/or humic acids on pseudostem height (cm), circumference (cm), leaf number and Leaf area (m^2) as well as days till flowering and maturity of Grand Naine banana plants growin during two growing seasons (2014/2015 and 2015/2016).

Fertilizers (A)	Humic acid ppm (B)	Pseudostem height (cm)		Circumference (cm)		Leaf number		Leaf area $(m)^2$		Days till Flowering		Days till Maturity	
		2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
100% RD	0	289	288	67.5	68	10.7	10.8	1.89	1.92	425	424	120	120
	750	297	297	70.2	71.2	11.2	11.5	1.92	1.98	418	414	112	111
	1500	301	302	73.4	75.2	11.7	11.8	2.18	2.24	416	413	107	105
	Mean	295.67	295.67	70.37	71.47	11.2	11.37	1.99	2.05	419.7	417	113	112
75% RD	0	264	267	64.2	64.7	10	10.3	1.66	1.69	427	427	118	116
	750	287	279	66.7	67	10.7	10.9	1.77	1.78	422	420	116	115
	1500	285	286	69.8	70.2	11.2	11.7	1.79	1.81	407	406	115	113
	Mean	278.67	277.3	66.9	67.3	10.63	10.967	1.74	1.76	418.67	417.67	116.3	114.67
50% RD	0	242	244	61.3	61.6	9.4	9.7	1.52	1.55	430	431	128	127
	750	263	265	64	64.3	9.8	10.3	1.63	1.67	428	428	124	123
	1500	274	276	67	67.7	10.6	10.8	1.68	1.72	427	426	123	123
	Mean	259.67	261.67	64.1	64.53	9.933	10.267	1.61	1.6467	428.3	428.3	125	124.3
75% RD+25 ton C	0	249	295	81.6	82	11.1	11.5	2.12	2.15	415	414	116	115
	750	303	294	85.2	85.6	11.7	12	2.32	2.37	412	411	114	113
	1500	309	310	89.3	89.7	12.1	12.5	2.45	2.6	410	410	111	111
	Mean	287	299.67	85.367	85.767	11.63	12	2.2967	2.373	412.3	411.67	113.67	113
75%RD+50 ton C	0	311	321	89.4	98.8	12.3	12.5	2.56	2.61	408	407	110	110
	750	314	315	93.2	93.5	12.6	12.9	2.74	2.78	406	405	108	107
	1500	318	319	96	96.7	13	13.2	2.88	2.92	403	403	106	106
	Mean	314.3	318.3	92.86	96.33	12.63	12.867	2.7267	2.77	405.67	405	108	107.67
50%RD+25 ton C	0	281	286	67.4	67.5	10.6	10.9	1.92	1.94	426	425	123	122
	750	296	296	70.2	71.8	11.3	11.6	1.94	2	424	425	120	122
	1500	299	301	73.8	74.2	11.5	11.7	2.32	2.36	422	422	118	117
	Mean	292	294.3	70.467	71.16	11.13	11.4	2.06	2.1	424	424	120.3	120.3
50%RD+50 ton C	0	290	249	83.2	83	11.4	11.7	2.08	2.16	418	417	119	118
	750	295	263	88.3	89	12	12.2	2.23	2.31	413	412	117	116
	1500	302	306	90.6	91.5	12.4	12.7	2.85	2.56	410	410	114	113
	Mean	295.67	272.67	87.367	87.83	11.93	12.2	2.3867	2.343	413.67	413	116.67	115.67
Overall mean	0	275.14	278.57	73.514	75.086	10.786	11.058	1.9643	2.0029	421.29	420.71	119.15	118.29
	750	293.57	287	76.83	77.49	11.33	11.63	2.08	2.13	417.57	416.43	115.86	115.29
	1500	298.29	300	79.99	80.74	11.79	12.06	2.31	2.32	413.57	412.86	113.43	112.57
New LSD at 5% for:													
A:		2.71	1.36	1.02	0.97	0.22	0.35	0.07	0.11	5.11	5.75	3.71	3.93
B;		1.53	1.77	1.11	0.73	0.31	0.37	0.13	0.09	4.31	4.11	4.11	4.33
AxB:		3.86	2.51	2.33	1.11	0.82	0.69	0.33	0.63	7.33	4.86	4.84	5.16

The favorable effects of organic fertilizers used in this study (compost and humic acid) on vegetative growth may be due to the high levels of nutrients availability and improving physical conditions and chemical properties of the soil, providing energy necessary for microorganism activity (Yadav and Luthra, 2004). Improving soil drainage, ventilation and increases soil ability to water retain and it improves holding capacity of soil and increases availability of nutrients were also reported which reflected positively on growth as well as yield and fruit quality were also reported (Lindani and Brutsch 2012). Moreover, Talha (2013) found that application of different composted materials were more effective in increasing available N,P, and K in the soil, plant organs, as well as some soil, physical and chemical properties such as bulk density and aggregate parameters. Similarly, it was found that, Humic acid play an important role as an antioxidants (oxygen free radical scavengers) such as ascorbic acid, citric acid, α-tocopherol, glutathione and vitamins. It is one of the new method used for plant production against adverse effects of environmental, reactive oxygen species (ROS) oxidative system (Helaly *et al*, 2017). In addition it was reported that humic acid increased plant growth, photosynthetic, activity and productivity of many plant species (Inskbashi and Iwaya 2006). It protecting chloroplast from oxidative damage by free radicals as reported by Aonou *et al,* (1993).

As for earliness Table 4 shows also that 75% RD of NPK supplemented with 50ton/feddan showed significant decreases in time to flowering and harvesting compared to the other treatments. Similarly supplementation of compost at 25ton to the 75% RD N+P+K treatment significantly decreased the period of flowering compared with the control (RD) plants. The longest period for flowering and maturity was found with plants received 50% RD of NPK without compost supplementation. Enhancement flowering and maturity with fertilizers may be due to the production of IAA and cytokinin by compost applications which increase the surface area per unit root length and encourage root hairs branching with an eventual (Yadav and Luthra 2004). It may be recorded due to the increase in absorption of nutrient from the soil and thus promote planr growth. (Lindani and Brutsch, 2012) who found that compost treatment increased availability of nutrients which reflected on growth and yield.

Concerning the effect of humic acid treatments on earliness, data in the same table show that days till flowering and maturity were decreased due to humic acid treatments. However, the differences between the two levels used (750 and 1500ppm) were small to reach the level of significant in both seasons. The interaction treatments between fertilizers and humia acid , show that all interaction treatments succeeded to decrease days till flowering and maturity of banana plants grandnaine cv in both seasons Again the combined treatments between 75% RD NPK+ 50ton compost and humic acid (1500 ppm) gave earlier flowering and maturity. The beneficial effects of humic acid on plant development may be due to its vital role as an antioxidant influences many biological processes. It play as a co-factors such as enhancement of cell division and/or cell enlargement (Arrigoni *et al* 1997). Similarly, the organic acid in the compost, like humic acid and fulvic acids make nutrients in the soil more available for plants to take up.

Yield and its components:

As for yield and its components, data in Table 5 show that plants fertilized with 75%RD NPK supplemented with 50 ton compost significantly increased bunch weight followed by 75%RD 25ton compost/feddan in both seasons. Similarly, supplementation of compost to 50%RD NPK showed an additive effects compared with that of the control. Therefore, plants received 75%RD NPK dose and supplemented with 50ton compost/fedden showed high bunch weight in both seasons. The increase in bunch weight due to compost application with the 75%RD NPK fertilizers may be attributed to an increase in cell division and elongation which caused an induction of vegetative growth, favoring physiological processes reflected on increasing yield and its components. Similar results were concluded (Jothimani, *et al,* 2013).

On the other hand, it was found that bunch weight were greatly affected by spray banana plants with humic acid compared with untreated plants in the two growing seasons. (Table5). The increase was a concentration dependent. The high dose the high yield. Similarly, all interaction treatments increased these parameters and showed an additive effect in this respect. The highest values were achieved in banana plants fertilized with 75% RD NPK +50ton compost and sprayed with 1500ppm humic acid.

As for fruit quality, data in Tables 5 and 6 show that interaction treatment between 75%RD NPK dose supplemented with 50ton compost and spraying with 1500ppm humic acid significantly increased physical and chemical parameters as indicated by finger weight, number of hands /bunch, number of fingers /hand, finger length and finger diameter. Similarly the high content of total sugars was recorded by 75% RD supplemented with 50 compost followed by 50 RD+ 50ton compost in both seasons. Moreover humic acid significantly showed an additive effect in this respect. It increased all parameters compared with the untreated plants. The most effective treatments was detected in plants fertilized with 75% RD N,P,K + 50ton compost and sprayed with 15000ppm humic acid.

The highest values of yield and fruit quality due to compost application may probably responsible for its effects on increasing growth and development of fruits, as well as nutrients uptake by the plants and their balances leading to enhancing chlorophyll content, photosynthetic activity and carbohydrate synthesis. Thus, photosynthates were accumulated and their distribution to the developing fruits. These results are in agreement with finding of Abdulraheem (2009). Mulani *et al*, (2007) added that because of higher yield and income, use of organic fertilizer are increasing, the highest fertilizer inputs can lead to marked deterioration in soil and ground water quality and the system are unsustainable.

The promotion additive effects of humic acid on banana yield and improving fruit quality may be due to its effects on alleviating the harmfull effects of the environmental stress to brought activation of root cell and their cytokinin biosynthetic capacity (Schmidt, 2005), enhancing leaf water statns (Demir *et al,* 2004), altering hormonal balances and favoring cytokinin, auxins production and antioxidant enzymes (Schmidt, 2005) enhancement biosyntheses, ascorbic acid and carotenoids which protect PSII photosynthetic apparatus (Zhang and Schmidt 2000) and stimulation of chloroplast development and phloem loading as well as delaying senescence (Demir *et al*, 2004). In this context, it was found that humic acid plays as a co factor for some specific enzymes such as superoxide dismutase, catalase and peroxidase which catalyzed breakdown the toxic H_2O_2, OH^- and O^- radical similar to other antioxidants (Elad, 1992).

Table 5. Effect of different doses of NPK fertilizers(RD) in the presence or absences of compost (C) and/or humic acid on bunch weight (kg), number of hand/bunch, number of finger/hand and finger weight(g) of Grand Naine banana plants grown during two growing seasons (2014/2015 and 2015/2016).

Fertilizers (A)	Humic acid ppm (B)	Bunch weight (kg)		number of hand/bunch		number of finger/hand		Finger weight (g)	
		2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
100% RD	0	20.2	21.4	9.67	10	15.33	15.67	93.67	93
	750	24	21	10.33	10.33	15.67	16	98	98.67
	1500	24.4	24.7	11.33	11.33	16.33	16.67	89.67	99.33
	Mean	22.87	22.37	10.44	10.563	15.78	16.11	93.78	97
75% RD	0	18.7	18.6	9	9	15	15	92.67	92.33
	750	26.2	26	9.67	9.67	15.33	15.33	93.33	93.33
	1500	27	27.2	11	11	16	16	94.33	94
	Mean	23.97	23.93	9.89	9.89	15.44	15.44	93.44	93.22
50% RD	0	16.3	16.4	8.33	8.33	14	13.67	89.33	89
	750	20.6	20.9	8.67	9	14.33	14.33	90	90
	1500	21.2	20.5	9.33	9.67	14.67	14.67	90.67	90.67
	Mean	19.37	19.27	8.78	9	14.33	14.22	90	89.89
75% RD+25ton C	0	25.6	25.8	11.33	11.67	16.33	16.67	101.33	101.67
	750	30.1	30.4	12	12	17	17	103	103.33
	1500	31.4	30.7	12.67	12.67	17.33	17.67	104.33	104.67
	Mean	29.03	28.97	12	12.11	16.89	17.11	102.89	103.22
75%RD+50ton C	0	32.5	32.9	13	13	17.67	17.67	105.33	103.67
	750	34.7	35.5	13.67	13.67	18.33	18	107	107
	1500	38.6	38.7	14.33	14.67	19.33	19.67	109	109.67
	Mean	35.27	35.7	13.67	13.78	18.44	18.45	107.11	106.78
50%RD+25ton C	0	24.7	25.2	10	10	16	16	95	95
	750	27.8	27.7	10.67	10.67	16.33	16.67	97.33	97.67
	1500	29.7	29.8	11.33	11.67	16.67	17	89.67	89.67
	Mean	27.4	27.57	10.67	10.78	16.33	16.56	94	94.11
50%RD+50 ton C	0	30.4	30.3	10.67	10.67	17	17	100.67	100.33
	750	32.1	32	11.33	11.33	17.33	17.67	102.33	101.67
	1500	34.7	34.3	13	13.33	18	18	104	103.33
	Mean	32.4	32.2	11.67	11.78	17.44	17.56	102.33	101.78
Overall mean	0	24.06	24.37	10.29	10.38	15.901	15.96	96.86	96.43
	750	27.93	27.64	10.91	10.95	16.33	16.43	98.72	98.81
	1500	29.57	29.41	11.86	12.05	16.90	17.1	97.39	98.76
New LSD at 5% for:									
A:		1.63	1.66	2.66	2.33	1.11	1.53	0.36	0.11
B;		1.11	1.06	1.23	1.66	0.90	0.96	0.17	0.13
AxB:		2.15	1.96	NS	NS	0.90	NS	0.63	0.19

Table 6. Effect of different doses of NPK fertilizers (RD) in the presence or absences of compost (C) and humic acid on Finger diameter (cm), finger length cm, Pulp/peel(%), total sugars% and Total acidity% of Grand Naine banana plants grown during the two growing seasons (2014/2015 and 2015/2016).

Fertilizers	Humic acid ppm (B)	Finger Diameter (cm)		Fnger length (cm)		Pulp /peel (%)		Total soluble solids%		Total sugars %		Total acidity g malic acid /100g pulp	
		2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
100% RD	0	2.8	2.9	15.14	15.25	1.87	1.84	15.3	15.5	15.88	15.96	0.41	0.41
	750	3.1	3.3	16.54	16.77	1.94	1.9	16.2	16.3	16.78	16.8	0.39	0.38
	1500	3.4	3.5	17.12	17.26	2.26	2.23	16.8	16.8	17.21	17.24	0.36	0.35
	Mean	3.1	3.23	16.27	16.43	2.02	1.99	16.1	16.2	16.63	16.67	0.39	0.38
75% RD	0	2.5	2.6	14.52	14.6	1.6	1.58	14.4	14.8	14.84	14.85	0.43	0.43
	750	2.6	2.8	15.4	15.3	1.7	1.65	15.4	15.6	15.24	15.38	0.4	0.4
	1500	2.8	2.9	16.2	16.32	1.78	1.79	16	16.2	15.9	15.94	0.38	0.39
	Mean	2.63	2.77	15.37	15.41	1.69	1.67	15.27	15.53	15.33	15.39	0.40	0.40
50% RD	0	2.3	2.4	14.24	14.36	1.56	1.58	14	14.1	14.26	14.34	0.44	0.44
	750	2.4	2.5	14.86	14.92	1.66	1.69	14.5	14.5	14.67	14.8	0.42	0.41
	1500	2.6	2.8	15.04	15.12	1.69	1.65	15.2	14.2	15.06	15.12	0.41	0.39
	Mean	2.43	2.57	14.7	14.8	1.64	1.64	14.57	14.27	14.66	14.7	0.42	0.41
75%RD+25 ton C	0	3.6	3.6	16.24	16.32	1.88	1.86	17.3	17.5	16.47	16.52	0.34	0.32
	750	3.7	3.8	16.75	16.8	2.17	2.12	17.8	17.9	16.85	16.92	0.31	0.3
	1500	3.9	4	17.34	17.4	2.43	2.42	18.2	18.7	17.06	17.12	0.28	0.27
	Mean	3.73	3.8	16.78	16.84	2.16	2.13	17.77	18.03	16.8	16.9	0.31	0.3
75%RD+50 ton C	0	4.1	4.2	17.6	17.64	2.77	2.78	19.2	19.7	17.66	17.68	0.25	0.26
	750	4.3	4.3	17.94	17.9	2.98	2.95	21.3	21.8	17.94	17.98	0.32	0.22
	1500	4.5	4.5	18.3	18.36	3.25	3.27	23.2	23.7	18.25	18.32	0.2	0.2
	Mean	4.3	4.33	17.95	17.97	3	3	21.2	21.7	17.95	17.99	0.26	0.23
50%RD+25 ton C	0	2.9	3	15.12	15.25	1.62	1.64	16.2	17	15.78	15.9	0.37	0.36
	750	3.3	3.3	15.86	15.98	1.67	1.63	16.7	17.4	16.86	16.87	0.35	0.34
	1500	3.5	3.6	16.62	16.76	1.74	1.72	17	17.7	17.18	17.2	0.33	0.31
	Mean	3.23	3.3	15.87	16	1.67	1.66	16.63	17.37	16.61	16.66	0.35	0.34
50%RD+50 ton C	0	3.4	3.4	15.2	15.24	2.16	2.18	17.4	17.7	16.8	16.87	0.27	0.28
	750	3.6	3.5	16.78	16.82	2.18	2.2	17.9	28	17.04	17.08	0.24	0.24
	1500	3.7	3.8	17.1	17.24	2.2	2.22	18.4	28.7	17.25	17.27	0.22	0.23
	Mean	3.57	3.57	16.36	16.4	2.18	2.2	17.9	24.8	17.03	17.07	0.24	0.25
Overall mean	0	3.09	3.16	15.44	15.5	1.92	1.93	16.26	16.62	15.96	16.02	0.359	0.357
	750	3.29	3.36	16.31	16.36	2.043	2.02	17.11	18.79	16.48	16.55	0.347	0.327
	1500	3.49	3.59	16.82	16.92	2.193	2.186	17.829	19.429	16.844	16.887	0.311	0.306
New LSD at 5% for:													
A:		0.25	0.31	0.76	0.66	1.33	1.53	0.66	0.67	0.60	0.33	0.07	0.03
B;		2.21	0.23	0.80	0.60	1.41	1.63	0.67	0.66	0.51	0.47	0.11	0.06
AxB:		0.34	0.41	1.00	0.90	1.66	2.03	1.66	0.97	0.66	0.63	0.33	0.09

Chemical constituents of the leaves

Data presented in Table7 show that the highest values of leaf N,P and K concentrations in banana were recorded with plants fertilized with 75%RD NPK supplemented with 50ton compost followed by 75%RD+ 25ton compost and 50%RD+ 50ton compost in both seasons. However, the lowest values of N,P and K concentrations were scored in plants received 50%RD NPK without compost supplementation in both seasons. In addition, it was found that humic acid application showed an additive effect in this respect. It increased N,P and K concentrations in banana leaves in both seasons. The interactions treatments between fertilizers and humic acid showed that the greatest N,P and K values of banana plants were obtained by the combination with 75%RD NPK + 25ton compost and sprayed with 1500 ppm humic acid. It was followed by 75% RD NPK supplemented with 50ton compost and spraying with humic acid at 1500ppm. These results are conforming with the finding of Upadhyaya and Sharma (2002) on cucumber. Talha (2013) found that, application of different composted materials were more effective in increasing available N,P and K in the soil, plant organs as well as some soil physical and chemical properties such as bulk density and aggregate parameters

Table 7. Effect of different doses of NPK fertilizers (RD) in the presence or absences of compost(C) and humic acids on percentages (%) of nitrogen(N), phosphorus(P)and potassium(K) as well as concentrations (mg/g F.Wt.) of, Chla,, Chlb, and carotenoids in the leaves of Grand Naine banana plants grown during two growing seasons (2014/2015 and 2015/2016).

Fertilizers	Humic acid ppm (B)	N %		P %		K %		Chl a mg/g F.Wt.		Chl b mg/g F.Wt.		Carotenoieds mg/g F.Wt.	
		2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015 /2016
100% RD	0	2.74	2.8	0.22	0.21	3.72	3.77	4.61	4.67	2.65	269	2.56	2.59
	750	2.96	2.98	0.23	0.23	3.83	3.86	4.78	4.81	2.69	271	2.64	2.68
	1500	3.04	3.07	0.23	0.23	3.95	3.98	4.91	4.96	2.77	279	2.72	2.77
	Mean	2.91	2.95	0.23	0.22	3.83	3.87	4.77	4.81	2.70	273	2.64	2.68
75% RD	0	2.52	2.55	0.21	0.21	3.54	3.56	4.48	4.53	2.56	2.58	2.51	2.56
	750	2.68	2.7	0.21	0.22	3.76	3.79	4.61	4.69	2.57	2.6	2.61	2.66
	1500	2.73	2.76	0.22	0.22	3.8	3.82	4.68	4.73	2.63	2.66	2.63	2.68
	Mean	2.64	2.67	0.21	0.217	3.7	3.72	4.59	4.65	2.59	2.61	2.58	2.63
50% RD	0	2.46	2.47	0.2	0.2	3.4	3.43	3.82	3.88	2.41	2.45	2.37	2.43
	750	2.6	2.64	0.2	0.21	3.58	3.61	3.94	4.02	2.48	2.53	2.41	2.45
	1500	2.67	2.7	0.21	0.21	3.7	3.72	4.05	4.11	2.52	2.57	2.46	2.53
	Mean	7.73	7.81	0.61	0.62	10.68	10.76	11.81	12.01	7.41	7.55	7.24	7.41
75% RD+25ton C	0	2.86	2.88	0.21	0.2	4.4	4.45	4.63	4.69	2.74	2.82	2.76	2.8
	750	2.96	2.98	0.22	0.21	4.62	4.64	4.72	4.77	2.86	2.93	2.81	2.86
	1500	3.02	3.05	0.22	0.21	4.72	4.69	4.88	4.93	2.92	2.96	2.88	2.92
	Mean	2.95	2.97	0.22	0.21	4.58	4.59	4.74	4.8	2.84	2.90	2.82	2.86
75%RD+50ton C	0	3.08	3.1	0.22	0.22	4.86	4.88	4.94	4.98	2.98	3.02	3.14	3.19
	750	3.16	3.19	0.23	0.22	4.94	4.97	5.47	5.51	3.17	3.11	3.25	3.31
	1500	3.21	3.23	0.24	0.24	5.07	5.12	5.71	5.74	3.23	3.27	3.32	3.38
	Mean	3.15	3.17	0.23	0.227	4.96	4.99	5.37	5.41	3.13	3.13	3.24	3.29
50%RD+25ton C	0	2.62	3.65	0.21	0.2	3.52	3.58	4.28	4.32	2.58	2.61	2.53	2.58
	750	2.83	2.85	0.21	0.21	3.73	3.78	4.41	4.47	2.64	2.68	2.59	2.63
	1500	2.96	2.98	0.22	0.21	3.8	3.81	4.52	4.57	2.73	2.77	2.74	2.79
	Mean	2.803	3.16	0.213	0.207	3.68	3.72	4.40	4.45	2.65	2.69	2.62	2.67
50%RD+50ton C	0	2.84	2.87	0.21	0.21	3.86	3.89	4.56	4.62	2.61	2.65	2.69	2.73
	750	2.99	3.01	0.21	0.22	3.91	3.92	4.67	4.71	2.69	2.72	2.77	2.83
	1500	3.09	3.12	0.22	0.22	4.02	4.08	4.93	4.98	2.74	2.78	2.81	2.86
	Mean	2.97	3	0.213	0.217	3.93	3.96	4.72	4.77	2.68	2.72	2.76	2.81
Overall mean	0	2.732	2.903	0.211	0.207	3.9	3.94	4.47	4.53	2.65	40.73	2.65	2.69
	750	2.883	2.91	0.216	0.217	4.05	4.08	4.66	4.71	2.73	41.08	2.73	2.77
	1500	2.96	2.987	0.223	0.22	4.15	4.18	4.81	4.86	2.79	42.28	2.79	2.85
New LSD at 5% for:													
A:		0.003	0.005	0.001	0.001	0.018	0.020	0.21	0.23	0.11	0.11	0.21	0.11
B;		0.003	0.002	0.002	0.001	0.021	0.017	0.13	0.16	0.06	0.09	0.13	0.13
AxB:		0.013	0.019	0.009	0.006	0.311	0.266	0.27	0.31	0.34	0.33	0.26	0.29

As for the photosynthetic pigments concentration (chlorophyll a, chlorophyll b and carotenoids) data in Table7 shows also that chl a,b and carotenoids concentrations were positively responded to fertilization and/or humic acid application. The greatest values were recorded in 75%RD NPK with 50ton compost followed with that received75% RD +25ton compost respectively. Similarly all photosynthetic pigments concentratins were increased due to foliar application of humic acid and the increase was a concentration dependent. The interaction treatments showed that photosynthetic pigments as indicated with chl a,b and carotenoids were affected significantly by fertilizers and foliar application with humic acid compared with the control. Therefore, humic acid produced an additive effect in this respect. The interaction between 75%RD

NPK supplemented with 50 ton compost and humic acid gave the high values of photosynthetic pigments compared with the individual application or the control plants. Humic acid play an impotant role as antioxidants (oxygen free radical scavengers) such as ascorbic acid, α tocopherol, glutathione and vitamins. It is one of the new method used for plant production against adverse effect of environmental, reactive oxygen species (ROS) oxidative system (Helaly, *et al* 2017). In addition, it was reported that humic acid increased plant growth, photosynthetic activity and productivity of many plant species (Inskbashi and Waya2006). It protecting chloroplast from oxidative damage by free radicals as reported by Aono, *et al*, (1993). In this context, it was found that humic acids plays as a co factor for some specific enzymes such as superoxide dismutase, catalase and peroxidase which catalyzed breakdown the toxic H_2O_2, OH^- and O^{--}radical similar to other antioxidants and thus protecting chloroplast (Elad, 1992). Increasing in photosynthetic pigments may be enhanced photosynthetic efficiency and that is a good explain to the increasing of banana yield.

CONCLUSION

In this study, the effects of organic fertilizers (compost and/or humic acid as a stimulators) on minizing mineral nutrition rate were achieved in order to decreasing the environmental pollution and high cost of banana production in Egypt. The addition of compost with or without humic acid minimizing the recommended values of mineral fertilization for banana production to about 50% without affecting significantly on its productivity. Using 50ton compost with spray banana plant with humic acid at 1500ppm three times gave best results with regard to growth, flowering and maximized its productivity. The data propose that the treatments of banana plants with 75%RD NPK with supplementation of 50 ton compost followed by spraying with humic acid at 1500ppm three times could be agriculture technology applicable to improvement growth, flowering as well as yield and fruit quality, Moreover, this study suggests that organic fertilizers may be involved in the metabolic or physiological activity in banana exposed to mineral dificiaty.

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الاستبدال الجزئي للتسميد الكيميائي لنباتات الموز عن طريق المحفزات العضوية.

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تم تقييم تأثيرات إضافة الكمبوست مع أو بدون حامض الهيومك كمحفزات عضوية تعمل على تقليل معدل التسميد المعدنى. ولهذا الغرض أجريت تجربتين حقليتين خلال موسمي الزراعة (2015/2014 و 2016/2015) بمزرعة خاصة في وادي النطرون، النوبارية، محافظة البحيرة، مصر على الصنف جراندنان المنزرع في التربة الرملية. وأوضحت االنتائج أن استخدام الكومبوست مع أو بدون حمض الهيومك يقلل من القيم الموصى بها من التسميد المعدني حوالي 50٪ دون التأثير على إنتاجيته. و لتعظيم إنتاجية الموز أوضحت النتائج أن إستخدام 50 طن كمبوست مع رش النبات (صنف جراندنان) ثلاث مرات شهريا بدءا من منتصف أبريل بحامض الهيوميك بتركيز 1500 جزء في المليون أعطى أفضل النتائج فيما يتعلق بمظاهر النمو مع تبكير الإزهار والنضج و لقد حفزت هذه المعاملة الموصى بها بين جميع مظاهر النمو المدروسة مع زيادة المحصول متمثلا فى وزن السوباطة و تحسين الخصائص الطبيعية والكيميائية للثمار بالمقارنة بمعاملة الكنترول.