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Effect of Soil Application with Humic and Amino acid on Vegetative Growth, Nutritional Statues, Yield and Fruit Quality of Grande Naine Banana Plants

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Abstract : This study was carried out in a private orchard, at El-khatataba region, Minofia governorate on 'Grande Naine' banana plants grown in sand soil during the 2013/2014 and 2014/2015 seasons to study the effect of different levels of humic acid(0.0, 5.0 and 10.0 g/L/plants/year) and amino acid (0.0, 0.5 and 1.0 g/L/plants/year either alone or in combinations. They were added into four doses during the first week of April to July on vegetative growth, Leaf(N, P, and K), content, yield, bunch characteristics and finger parameters were determined. The results indicated that, all treatments with humic acid and amino acid alone or in combinations treatments increased all vegetative growth parameter under study in both seasons .Meanwhile, soil applied with humic acid and amino acid combination increased leaf (N) and (K) content in both seasons .In addition, the treatment of soil applied with l.0g /L humic acid +lg/L amino acid gave the highest values for the above yield and Bunch weight. However, fruit quality (physical and chemical characteristics) was significantly improved by soil applied with different humic and amino acid treatments either alone or in combinations.

Keywords : Humi acid - vegetative growth - Banana plants -Amino acid- yield and fruit quality.

Introduction

Banana (Musa Cavendishi Lamb) is considered as one of the most important fruit in tropical and subtropical regions of the world. Banana fruits are considered good source of energy and vitamins A;B_6 and C [1]. Using banana compost and chicken manure induced similar nitrogen fertilizer and gave the best fruit characteristics [2]. Fertilization is an important and limiting factor for growth and productivity of banana plants because banana plants remove large amounts of nutrients from the soil,among these nutrients, nitrogen is considered the prime nutrient for growth of plants.

Humic materialsmay also increase root growth in a similar manner to auxins [3]. However, Humic acid increases plant growth through chelating different nutrients to overcome the lack and nutrients and have appositive effectson growth increase, production and quality improvement of agricultural products due to having hormonel compounds [4].Humic acid foliar spray has remarkable effects on

vegetative growth of plant and increases photosynthetic activity and leaf area index [5]**.** The aim of this investigation is to study the effect of soil application with Humic and Amino acid at different concentrations either alone or in combinations on vegetative growth, nutrients yield and fruit quality of banana plants.

Materials and Methods

This study was carried out in a private orchard at EL-Khatataba region, Minofia Governorate Egypt, during the seasons of 2014 and 2015 seasons of Grande Naine plant, the suckers were planted 3x3.5m. a part in March 2013 mother plant. The experimental soil in texture and deficient in fertility according to mechanical and chemical analysis **(Table1)**

Table (1): Soil characteristics of the banana plantation at the start of the experiment.

Physical character	value	chemical constitute	value
Clay %	5	N	0.90
Silt %	5	P	0.28
Sand %	90	K	0.35
Texture	Sandy	Available micro nutrients (ppm)	
Esmmhos / 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		

Compositionof amino acid(Table 2): The amino acids contained in amino Zaid 42/85 in L-α type (alpha position) , total amino acids college boat and 85% (free amino acids super concentrate 42.3%) and containing 10% organic nitrogen + 2.5% potassium oxide

Table (2): Typical amino acid profile (W/W %):

Amino acids	%	Amino acids	%
Aspartic	3.29%	Lysine	1.75%
Tyrosine	0.52%	Arginine	4.57%
Glutamic	8.18%	Histidine	0.56%
Glycin	2.03%	Proline	3.96%
Alanine	2.26%	Phenyl alanine	0.99%
Valine	2.51%	Serine	4.99%
Isoleucine	1.11%	Threonine	3.57%
Leucine	2.03%		

Composition of humic acid: Guaranteed analysis, Humic acid 80%; potassium (K_2O) 10-12%;Zn,Fe,Mn,etc. 100ppm.

Experimental plants received the same horticulture practices expected for the amount and applied treatments. The experiment was designed to evaluate the effect of humic and amino acids on vegetative growth, nutritional status, yield and fruit quality of Grande Naine banana plants. This experiment consisted of humic acid at three levels (0.0,5.0 and 10g/L/plant/year)and amino acid at three levels(0.0,0.5 and 1.0 g/L/plant/year) as alone or in combinations added into four doses equal as aliquid suspension during the first week of April to July for each seasons.

Growth characters:

Al bunch shooting stage, the following growth characteristics were recorded: pseudostem height, pseudostem circumference (cm), number of green leaves per plant as well as assimilation area/plant (m^2) was determined using the equation = leaf area x number of green leaves plant [6]. Data of each plant were individually recorded: Bunch characteristics: number and hand /bunch and number of finger /hand were determined finger parameters: finger weight, length and diameter were determined.

Yield characteristics:

At time of harvest, bunch weight/kg and yield/ton was determined.

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. Total nitrogen was determined by micro-kjeldahle method as described by [7]**,** phosphorus was determined by according to the method of [8] and K was determined by using the Atomic absorption Spectrometers (Perkin – Elemer, Model 3300) according to the methods described by [8]**.**

Statistical analysis:

The obtained data was subjected to analysis of variance, for factorial plot design in a randomized complete blocks with five plants in replicates and three replicates in each treatment[9]**.** The mean was compared by using the method of new least significant differences (New L.S.D at 0.05) described by [10]**.**

Results and Discussion

1-Vegetative growth:

Data tabulated in table (3) disclosed that, all combination treatment raised pseudostem height, pseudostem circumference and number of green leaves / plant as compared with the other treatment or the control in both seasons. However, soil applied with 10g/L humicacid + 1 g/L Amino acid ; 10 g/L humic acid + 0.5 g/L amino acidand 5g/L humic acid +1 g/L amino acid treatments gave the highest pseudostem height and pseudostem circumference followed by soil applied with 5 g/L humic acid +0.5 g/L amino acid as compared with the other used treatments or the control in both seasons. Meanwhile, soil applied with 10 g/L humic acid +1 g/L amino acid in both seasons treatment gave general higher values of number of green leaves/plant as compared with the other used treatments and the control. On the other hand, the plants which were fertilized with either humic acid (at 5 and 10 g/L) andamino acid at 0.5 g/L reflected the least values of all fruiting parameters during both seasons of study.

Table (3): Effect of soil applied with humic acid and amino acid on some vegetative growth of Grand Naine banana plants during 2014 and 2015 seasons.

Treatment	Pseudostem height(cm)		Pseudostem circumference(cm)		No. of green leaves/plant	
	2014	2015	2014	2015	2014	2015
T1:Control (recommended doses)	229.67f	241.33e	67.33f	6867f	9.67f	9.33f
T2: 5g/L humic acid	270.33e	278.33d	75.00e	73.33e	10.33ef	1033def
T3: 10g/L humic acid	274.00e	281.33d	78.67de	76.67de	10.33ef	10.67cde
T4: 0.5g/L amino acid	289.33d	283.33cd	82.33cd	80.33cd	10.67def	10.00ef
T5: 1g/L amino acid	295.33c	291.33bc	85.00bc	78.67cd	11.00cde	10.67cde
T6: 5g/L humic acid+0.5g/L amino acid	300.00b	292.00bc	86.33bc	81.67c	11.67bcd	11.33bcd
T7: 5g/L humic acid+1g/L amino acid	307.00a	297.67ab	88.33ab	82.67bc	12.00abc	11.67abc
T8: 10g/L humic acid+0.5g/L amino acid	306.00a	302.67a	90.67a	86.33b	12.67ab	12.33ab
T9: 10g/L humic acid+1g/L amino acid	306.33a	305.00a	91.00a	91.00a	13.00a	12.67a

It is clear from table (4) that leaf area and assimilation area of Grand Naine banana plants were significantly promoted by soil applied with 10 g/L humic acid +1 g/L amino acid as well as 10 g/L humic acid +0.5 g/L amino acid followed by soil applied with 5 g /L humic acid + 1 g/L amino acid as compared with the other used treatment or the control of both seasons. On the other hand, no significant difference was obtained between humic acid and amino acid were used when leaf area and assimilation area were concerned in both seasons. Also all treatments under investigation increased leaf area and assimilation area as compared with the control during both seasons.

Table (4): Effect of soil applied with humic acid and amino acid on leaf assimilation area of Grand Naine banana plants during 2014 and 2015 seasons.

Treatment	Leaf area (cm^2)		Assimilation area (m^2/plant)	
	2014	2015	2014	2015
T1:Control (recommended doses)	1.53f	1.56e	14.81d	14.51d
T2: 5g/L humic acid	2.00e	1.91d	20.60c	19.68c
T3: 10g/L humic acid	2.23d	1.82d	23.10c	19.39c
T4: 0.5g/L amino acid	2.13de	1.90d	22.69c	19.06c
T5: 1g/L amino acid	2.18d	1.98d	23.87c	21.15c
T6: 5g/L humic acid+0.5g/L amino acid	2.57c	2.49c	30.05b	28.19b
T7: 5g/L humic acid+1g/L amino acid	2.69bc	2.66bc	32.33b	31.02b
T8: 10g/L humic acid+0.5g/L amino acid	2.83ab	2.79ab	35.88a	34.41a
T9: 10g/L humic acid+1g/L amino acid	2.90a	2.87a	37.68a	36.32a

Generally, all treatments with humic acid and amino acid alone or in combinations treatment considerably increased vegetative growth of Grand Naine plants under study in both seasons. Humic acid materials maybe increased root growth in manner similar to auxine. The available literature in this concern was reported by [11] on banana Williams; [12] on grape and [13] on banana plants, they reported that humic acid increased growth parameters and caused noticeable increase in height and girth pseudostem; number of green leaves and accelerated fruit maturity.

2-Leaf nutrient contents:

Table (5) shows that the highest percentage of N content (3.23 and 3.20) resulted from soil applied with 10 g/L humic acid +1 g/L amino acid treatment in both seasons as well as soil applied with 5 g/L humic acid + 1 g/L amino acid treatment (3.18 and 3.17) in both seasons, respectively,

Meanwhile, the lowest percentage of N content (2.68 and 2.72) was produced from the control in the 2014 and 2015 seasons. On the other hand, no significant difference was obtained between all different concentration of humic acid ; amino acid the control were used when leaf phosphorus content were concerned in both seasons. Also, all treatments under investigation increased leaf K content during the two seasons. However, the highest K(%) was recorded with 5 g/L humic acid + 1 g/L amino acid, 10 g/L humic acid +0.5 g/L amino acid; 10 g/L humic acid + 1 g/L amino acid in the first season as well as 10 g/L humic acid + 1 g/L amino acid in the second season as compared with the other used treatments the control in both seasons.

Generally, soil applied with humic acid and amino acid combination increased leaf N and K content in both seasons. Also, leaf P was not affected in both seasons. The present influence of humic acid was attributed to their positive action on the biosynthesis of proteins and carbohydrates [14]. Meanwhile, it humic acid is also considered to improve soil nitrogen uptake and encourage the uptake of potassium, calcium, phosphorus and magnesium, making these more mobile and available to plant root system [15,16].

Table (5): Effect of soil applied with humic acid and amino acid on leaves contents of N, P, K of Grand Naine banana plants during 2014 and 2015 seasons.

Treatment	N (%)		P (%)		K (%)	
	2014	2015	2014	2015	2014	2015
T1:Control (recommended doses)	2.68g	2.72e	0.22a	0.22a	3.12f	3.58e
T2: 5g/L humic acid	2.76f	2.87d	0.22a	0.21a	3.33e	3.81d
T3: 10g/L humic acid	2.88e	2.91d	0.23a	0.22a	3.42d	3.92c
T4: 0.5g/L amino acid	2.96d	3.00c	0.22a	0.21a	3.48c	3.93c
T5: 1g/L amino acid	3.05c	3.04c	0.22a	0.21a	3.49bc	3.96c
T6: 5g/L humic acid+0.5g/L amino acid	3.15b	3.12b	0.23a	0.23a	3.54b	4.05b
T7: 5g/L humic acid+1g/L amino acid	3.18a	3.17ab	0.23a	0.23a	3.61a	4.06ab
T8: 10g/L humic acid+0.5g/L amino acid	3.17ab	3.18ab	0.22a	0.21a	3.65a	4.06ab
T9: 10g/L humic acid+1g/L amino acid	3.23a	3.20a	0.21a	0.22a	3.64a	4.12a

3-Yield and bunch weight:

Table (6) shows that yield /fed and bunch weight tented to increase by all combinations treatment under study in both tested seasons respectively. The obtained data also shows that the heaviest bunches (29.11 and 31.20kg/plant) and yield (32.02 and 34.32 ton/fed.) were obtained from the plants soil applied with 10 g/L humic acid + 0.5g/L amino acid as well as 10 g/L humic acid + 1 g/L amino acidwhilst the highest bunches (16.38kg/plant) and yield (18.02 ton/fed.) were obtained from the plants soil applied with 5 g/L humic acid in the first season.

Generally, it could be concluded that the treatment of soil applied with 10 g/L humic acid + 1 g /L amino acid gave the highest values for the above yield and bunch weight of Grande Naine banana, the available literature in this concern were reported by [17] on banana plants; [11,18]on crimson seedless grapevine. They reported that, soil applied with humic acid with organic fertilizer significantly increased yield than the organic fertilizer alone.

Table (6): Effect of soil applied with humic acid and amino acid on yield and bunch characteristics of Grand Naine banana plants during 2014 and 2015 seasons.

Treatment	Bunch weight (kg)		Yield (ton/feddan)	
	2014	2015	2014	2015
T1:Control (recommended doses)	14.18f	15.45de	15.60f	16.99de
T2: 5g/L humic acid	16.38ef	14.26e	18.02ef	15.68e
T3: 10g/L humic acid	18.18de	18.61cd	19.99de	20.47cd
T4: 0.5g/L amino acid	19.81cd	16.40cde	21.79cd	18.04cde
T5: 1g/L amino acid	22.39bc	19.65c	24.63bc	21.61c
T6: 5g/L humic acid+0.5g/L amino acid	25.57b	23.51b	28.12b	25.86b
T7: 5g/L humic acid+1g/L amino acid	25.50b	23.61b	28.05b	25.97b
T8: 10g/L humic acid+0.5g/L amino acid	29.11a	24.79b	32.02a	27.27b
T9: 10g/L humic acid+1g/L amino acid	31.20a	28.98a	34.32a	31.87a

4-Fruit characteristics:

a- Fruit physical properties:

It is clear from table(7) that all combination treatments were significantly more superior in improving most of the studies parameters of both seasons as it increased the number of hands/bunch; hand weight; number of fingers/hand and finger weight as compared with the other used treatments. The highly remarkable positive difference in this respect was observed when the plants were soil applied with either 10 g/L humic acid + 1 g/L amino acid or 10 g/L humicacid + 0.5 g/L amino acidas compared with the other used treatments in both seasons. On the other hand, the plants which were soil applied with either 5 g/L humic acid; 10 g/L humic acid reflected the least values of all physical characterististics parameters during both seasons of study.

Table (7): Effect of soil applied with humic acid and amino acid on physical characteristics of bunch and fingers of Grand Naine banana plants during 2014 and 2015 seasons.

Treatment	No. hands/bunch		Hand weight (kg)		No. fingers/hand		Finger weight (g)	
	2014	2015	2014	2015	2014	2015	2014	2015
T1:Control (recommended doses)	10.00e	10.67cd	1.42f	1.45e	15.00e	15.67de	94.67d	92.67d
T2: 5g/L humic acid	11.00de	10.00d	1.49ef	1.43e	15.67de	15.33e	95.00d	93.33cd
T3: 10g/L humic acid	11.33d	11.67bc	1.60de	1.60de	16.67cd	16.67bcde	96.33d	95.67cd
T4: 0.5g/L amino acid	12.00cd	10.67cd	1.65cd	1.54de	17.00c.	16.33cde	97.00d	94.00cd
T5: 1g/L amino acid	12.67bc	11.67bc	1.77c	1.68cd	17.33bc	17.33abcd	102.00c	97.00c
T6: 5g/L humic acid+0.5g/L amino acid	13.00abc	12.67ab	1.96b	1.86bc	18.33ab	18.33ab	107.00b	101.33b
T7: 5g/L humic acid+1g/L amino acid	12.67bc	12.33ab	2.01b	1.92ab	18.33ab	18.33ab	109.67b	104.67b
T8: 10g/L humic acid+0.5g/L amino acid	13.33ab	12.33ab	2.18a	2.00ab	18.67a	18.00abc	117.00a	111.33a
T9: 10g/L humic acid+1g/L amino acid	14.00a	13.67a	2.23a	2.12a	19.00a	18.67a	117.33a	113.67a

Also, data in table (8) indicated that growth parameters of plant i.e. (finger length, finger diameter and pulp weight) were gradually and significantly increased by soil applied with all combination treatments as compared with the other treatments and the control in both seasons. Meanwhile, soil applied with 10 g/L humic acid + 0.5 g/L amino acid in the first season as well as the control in the both seasons gave the highest peel weight as compared with the other used treatments in both seasons. However, soil applied with 5 g/L humic acid + 0.5 g/L amino acid in both seasons as well as soil applied with 10 g/L humic acid + 1 g/L amino acid and soil applied with 0.5 g/L amino

acid in the second season treatment gave general higher values of pulp/peet ratio as compared with the other used treatments and the control in both seasons.

Generally, fruit physical characteristics such as (No. hands/bunch; hand weight; No. fingers/hand; finger weight; finger length and finger diameter) were improved by different studied treatments. These results are in harmony with those reported by [19] on canino apricot trees and [20] on Grande Naine banana plants. They reported that fruit physical characteristics were improved by the different soil applied treatments.

Table (8): Effect of soil applied with humic acid and amino acid on some fruit physical characteristics of Grand Naine banana plants during 2014 and 2015 seasons.

Treatment	Finger length (cm)		Finger diameter (cm)		pulp weight (g)		Peel weight (g)		Pulp/peel (ratio)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T1:Control (recommended doses)	14.30f	15.05d	3.46f	3.47d	58.67f	58.00f	36.00a	34.67a	1.63f	1.70c
T2: 5g/L humic acid	15.06e	14.17e	3.53e	3.44d	65.00e	62.33e	30.00b	31.00abc	2.17e	2.03bc
T3: 10g/L humic acid	15.82d	16.30bc	3.60d	3.60c	69.00d	65.33de	27.33bc	30.33abc	2.56cde	2.15ab
T4: 0.5g/L amino acid	16.35c	15.90c	3.61d	3.50d	68.67d	67.33d	28.33bc	26.67c	2.43de	2.55a
T5: 1g/L amino acid	16.75c	16.52b	3.72c	3.68c	76.33c	68.00cd	25.67cd	29.00bc	3.01bc	2.35ab
T6: 5g/L humic acid+0.5g/L amino acid	17.42b	17.95a	3.91b	3.88a	84.00b	72.33b	23.00d	29.00bc	3.67a	2.51a
T7: 5g/L humic acid+1g/L amino acid	18.15a	17.87a	3.92b	3.78b	84.00b	71.00bc	25.67cd	33.67ab	3.29ab	2.15ab
T8: 10g/L humic acid+0.5g/L amino acid	18.17a	18.15a	3.99a	3.91a	86.67ab	79.00a	30.33a	32.33ab	2.86bcd	2.44ab
T9: 10g/L humic acid+1g/L amino acid	18.30a	18.23a	4.02a	3.93a	89.67a	81.33a	27.67bc	32.33ab	3.26ab	2.52a

b- Chemical properties:

Data tabulated in table (9) disclosed that T.S.S. content; T.S.S./acidity and total sugar increased by soil applied with all combinations treatment in both seasons as compared with the other used treatments and the control. Meanwhile, all combination treatments with soil applied significantly decreased total acidity % compared with all treatments with humic ,amino acid and the control in both seasons , moreover, it was observed that soil applied with 10g/L humic acid+0.5g/L amino acid in both seasons as well as soil applied with10g/L amino acid +1g/L amino acid in the first season resulted in the lowest value in total acidity% applied with 10g /L humic + 0.5g L amino acid and 10g/L humic acid + 1g/L amino acid in both seasons treatment gave general higher values of increasing sugar contents as compared with the other used treatments and the control. Besides in both seasons soil applied with 10g/L humic + 0.5g /L amino acid and 10g/L humic acid + 1g/L amino acid decreased significantly starch content followed by soil applied with 5g/L humic acid +1g/L amino acid treatment as compared with the other used treatments and the control.

Generally, all combination treatments increased most fruit chemical properties under study.

The favorable effect of humic and amino acid on fruit chemical properties is in accordance with reported by [13];[21] and[22]. They reported that amino acid and humic acid applied with high rate combined by the highest microelement levels were demonstrating the favorable treatments of Grand Naine banana plants.

Table (9): Effect of soil applied with humic acid and amino acid on some fruit chemical characteristics of Grand Naine banana plants during 2014 and 2015 seasons.

Treatment	Total soluble solids (T.S.S) (%)		Total acidity (T.A.) (%)		T.S.S/Acidity		Total sugar		Starch	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T1:Control (recommended doses)	19.20g	21.00b	0.43a	0.41ab	44.77e	51.66c	16.53f	16.72cd	2.13a	2.08ab
T2: 5g/L humic acid	21.04f	19.29d	0.42ab	0.44a	50.12de	44.25d	17.55e	16.12e	2.09ab	2.11a
T3: 10g/L humic acid	21.26e	20.52c	0.40abc	0.40b	53.64cd	51.78c	17.84d	16.51d	2.06b	2.04b
T4: 0.5g/L amino acid	21.62d	20.85bc	0.39bc	0.41b	55.11cd	50.54c	17.99cd	16.85c	1.95c	1.93c
T5: 1g/L amino acid	21.90c	20.98b	0.38cd	0.40b	57.81c	52.05c	18.34ab	16.88c	1.88d	1.89c
T6: 5g/L humic acid+0.5g/L amino acid	2198bc	21.99a	0.35de	0.35c	63.50b	62.31b	18.09bcd	17.16b	1.78e	1.73d
T7: 5g/L humic acid+1g/L amino acid	22.03b	21.87a	0.33ef	0.37c	67.46ab	59.69b	18.20bc	17.16b	1.65f	1.63e
T8: 10g/L humic acid+0.5g/L amino acid	22.20a	22.12a	0.31f	0.31d	70.97a	70.81a	18.49a	18.28a	1.44g	1.50f
T9: 10g/L humic acid+1g/L amino acid	22.26a	22.18a	0.31f	0.36c	72.15a	62.26b	18.62a	18.47a	1.43g	1.50f

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