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GROWTH, FRUIT QUALITY AND YIELD OF MANGO TREES AS AFFECTED BY SOME BIO AND MINERAL NITROGEN FERTILIZERS

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ABSTRACT: *This study was carried out on seven years old of Zebda mango trees grown in clay loam soil under surface irrigation at mango orchard belonging to Horticulture Research Station at El-Kanater El-Khaira Barrage, Kalyubeia Governorate, Egypt, thirty six trees were selected for these study during the two successive seasons 2010 and 2011, to study the effect of soil inoculation with three bactrian strains (Azotobacter chrococcum, Azospirillm lipoferum or Bacillus polymyxa) and two sources of mineral nitrogen fertilizers (ammonium nitrate or ammonium sulphate) each applied solely at 1000 g actual N/tree, as well as the possible combinations between inoculation of any bio-N fertilizer from one hand and 500 g N of either* NH_4NO_3 *or* $(NH_4)_2SO_4$ *from the other, besides the N fertilization program adopted in the farm as control. The obtained results were as follows:*

1- ***Growth measurements:*** *The highest records of the studied growth parameters were obtained from trees inoculated with Bacillus polymyxa combined with either 2.5 kg of* $(NH_4)_2SO_4$ *or 1.5 kg* NH_4NO_3 *per tree (500 g. N/plant).*
2- ***Leaf mineral content:*** *Inoculation with Azotobacter chrococcum or Bacillus polymyxa + either* NH_4NO_3 *or* $(NH_4)_2SO_4$ *treatments were statistically the most simulative for increasing leaf mineral content. However, Bacillus polymyxa + either* NH_4NO_3 *or* $(NH_4)_2SO_4$ *was the superior as leaf N and P were concerned, while Azotobacter chrococcum + either* NH_4NO_3 *or* $(NH_4)_2SO_4$ *was the superior for leaf K content.*
3- ***Yield and fruit quality:*** *Inoculation with Bacillus polymyxa +* $(NH_4)_2SO_4$ *at 500 g N/tree was the most effective treatment on yield as kg/tree, fruit length, diameter and weight and total soluble solids % while values of fruit shape index and acidity % were decreased.*

Therefore, inoculation with either Azotobacter chrococcum or Bacillus polymyxa as an additional bio-N fertilizer combined with mineral N fertilizer (ammonium nitrate or ammonium sulphate) each at 500 g actual N/tree could be safely recommended as an applicable N fertilization program under similar conditions of our study.

Key words: *Mango trees, bio-fertilizer, mineral fertilizer, growth, fruit quality, mineral content.*

INTRODUCTION

Mango is one of the important fruit in the tropics and subtropics. In Egypt, mango is considered the most popular fruit and occupies the third place in acreage after citrus and grapes. The area of mango orchard 209040 feddans, producing about 505741 tons of fruit annually (Ministry of Agric. Statistics, 2010). It is well know that many problems face and affect mango productivity, i.e., poor fruit set and high fruit drop percentage at different fruit growth stages. Also, it is well know that, the important role of minerals in growth, flowering and fruiting of plants is one of the noteworthy achievements of science. Nitrogen, being one of the most important nutritive elements plays a dominant role in plant nutrition. Consequently, the importance of nitrogen in the structure and metabolism of the plant leads to the necessity of having enough nitrogen supply in the soil (Osman and Abou-Taleb, Safia, 1998 and Abou-Taleb, Safia *et al*., 2004).

In Egypt, the majority of agriculture is mainly dependent on mineral fertilizers, which is energy consuming and expensive (Soliman, 2001). Moreover, the nitrogenous fertilizers are lost via nitrate reduction, denitrification and ammonia volatilization (Zaghloul, 2002).

Also, some nitrogenous fertilizers can be leached to the surface and underground water causing environmental pollution (Attia, 1990). Therefore, the use biofertilizers is a particular interest to avoid the previously mentioned problems, accompanied by the urgent demand to protect agroecosystem from damage (sustainable agriculture) (Herridge *et al*., 1994). Biofertilizers application with a half dose of chemical nitrogen fertilizer proved to be an efficient tool in increasing available nutrients in the soil as well as growth performance and yield of cultivated crops are also improved (El-Demerdash, 1994; Abd El-Mouty *et al*., 2001 and Zaghloul, 2002).

Inoculation with biofertilizer contained bacteria led to increase plant dry weigh, leaf chlorophyll content, helps in availability of minerals and their forms in the composted material and increases levels of extractable N, P, K, Fe, Zn and Mn (Saber and Gomaa, 1993 and El-Kramany *et al*., 2000).

In addition, production of growth regulators, protection from root pathogens and modification of nutrient uptake by the plant as related to biofertilizer application were also demonstrated by Tchan, 1988. Using of improved and combined inoculum formulations very much promise for increasing yield in many important crops (Shahaby *et al*., 1993; Awasthi *et al*., 1998; Barakat and Gaber, 1998; Fernandez *et al*., 1998; Tiwary *et al*., 1998; Soliman, 2001 and Zaghloul, 2002).

However, research work dealing with particular species of bacteria on mango is very rare (Elham *et al*., 2005).

The main target of this study was examining the effect of soil inoculation with three bacterial strains (Azotobacter chrococcum, Azospirillum lipoferum and Bacillus polymyxa) solely or combined with two sources of chemical nitrogen fertilizers (ammonium nitrate or ammonium sulphate) on vegetative growth, yield, fruit quality and leaf chemical constituents of Zebda mango trees.

MATERIALS AND METHODS

The present study was conducted during two successive experimental seasons (2010 – 2011) on Zebda mango cultivar (*Mangifera indica* L.) at mango orchard belonging to Horticulture Research Station at El-Kanater El-Khaira Barrage, Kalyubeia Governorate, Egypt.

The mango trees were about 7-years old when this study started, planted according to square system at 7 meters apart, the soil orchard was clay loam. The trees received the regular cultural treatments by the Ministry of Agriculture and irrigated through farrow (surface) irrigation system. Soil types were taken from a depth of 0 – 90 cm, from ground surface and were physically and chemically analysed before period of equilibration and determined at Agricultural Research Center and the obtained data are shown in Table (1).

Thirty six trees uniform in their vigor, size, shape and disease free, were selected for the investigation to cover vegetative growth measurements, yield, nutritional status and fruit quality studies.

The trees selected for the experiment were kept under the normal cultural practices, except for the treatments of this investigation.

This experiment was carried out in order to study the effect of soil inoculation with three bio-N fertilizers (*Azospirillm lipoferum, Azotobacter chrococcum* and *Bacillus polymyxa*) each applied solely or combined with two sources of chemical nitrogen fertilizers (ammonium nitrate or ammonium sulphate) on the vegetative growth, leaf chemical constituents, yield and fruit quality of Zebda mango trees.

The Randomized Complete Block Design with three replicates was used. Each replicate involved twelve treatments and each treatment was represented by one tree.

Table (I): Physical and chemical soil properties of the experimental field.

Soil parameter	Values
Particle size distribution (%):	
Coarse sand %	1.10
Fine sand %	34.0
Silt %	33.5
Clay %	31.4
Textural class	clay loam
$CaCO_3$ g/kg	37.5
Organic matter g/kg	18.0
* Available K mg/kg	193.3
* Available P mg/kg	9.12
pH (1:2.5 w/v soil : suspension)	7.75
EC (on saturation extract) dSm-1	1.0
S. P. (saturation percent)	67.5
Cations and anions in soil paste extract (mmolc/L)	
Ca^{++}	2.97
Mg^{++}	2.73
Na^{+}	4.20
K^{+}	0.31
HCO_3^{-}	3.65
$CO_3^{=}$	0.0
Cl^{-}	4.0
$SO_4^{=}$	2.56

* Extracts of NH_4-acetate (for K) and sodium bicarbonate (for P).

Investigated N fertilization treatments and their application:

In this respect two mineral N fertilizers (ammonium nitrate – 33.5% N and ammonium sulphate – 20.5 % N each at 1000 g N / tree) and three bacterial strains of bio-N fertilizers (*Azospirillm lipoferum, Azotobacter chrococcum* and *Bacillus polymyxa*) each applied solely, as well as the possible combinations between inoculation of any bio-N fertilizer from one hand and 500 gm N of either NH_4 NO_3 or $(NH_4)_2$ SO_4 from the other, besides the N fertilization program adopted in the farm (ammonium sulphate & ammonium nitrate as 1:2) as control were investigated.

Thus, the twelve mineral and bio-N fertilization treatments included in such experiment were as follows:

1 - Ammonium nitrate (NH_4 NO_3) solely at 3.0 Kg/tree a year.
2 - Ammonium sulphate ($(NH_4)_2$ SO_4) solely at 5.0 Kg/tree a year.
3 – Azospirillum lipoferum (Al) inoculation solely.
4 - Azotobacter chrococcum (Ac) inoculation solely.
5 – Bacillus polymyxa (Bp) inoculation solely.
6 – (Al) inoculation + 1.5 kg NH_4 NO_3
7 – (Al) inoculation + 2.5 kg $(NH_4)_2$ SO_4
8 – (Ac) inoculation + 1.5 kg NH_4 NO_3
9 – (Ac) inoculation + 2.5 kg $(NH_4)_2$ SO_4
10 – (Bp) inoculation + 1.5 kg NH_4 NO_3
11 – (Bp) inoculation + 2.5 kg $(NH_4)_2$ SO_4
12 – Control (adopted N fertilization regime in the farm).

The corresponding amount of each mineral N fertilizer for a given treatment was fractionated into 3 equal doses, applied in Feb., May and July by mixing with the soil surface layer (20.0 cm depth) surrounding the trunk till the external end of canopy shade.

Origin and preparation of the microorganisms for inoculation:

Azospirillm lipoferum, Azotobacter chrococcum and *Bacillus polymyxa* were provided from the Microbiology Dept. Soil & Water and Environment Res. Instit., Agric. Res. Center, Giza, Egypt. Modified Ashby's medium (Abdel-Malek and Ishac, 1968) and semi-solid malate (Dobereiner, 1978) were inoculated with *A. chrococcum* and *A. lipoferum* respectively, then incubated at 30 °C and 32 °C for 7 days, respectively. Also, Bunt and Rovira medium (1955) modified by Abdel–Hafez (1966) was inoculated with *B. polymyxa* then incubated at 30 °C for 7 days. One liter from each of the previously prepared bacterial strain was diluted with 10 liters of water, then distributed at 2 liters/tree. The inoculation was applied twice a year (in March and June).

Measurements:

1- Vegetative growth:

At the end of each growing season average twig length, leaf area (using the following equation as reported by Ahmed and Morsy, 1999), number of leaves and dry weight of leaves per every labeled twig were measured.

Leaf area (cm^2) = 0.70 [the maximum length of leaf (cm.) x the maximum width of leaf (cm.)] – 1.06

2- Leaf N, P and K contents:

Sampled leaves from each tree (replicate) were separately oven dried at 70 °C till a constant weight, then grounded for determination of the following nutrient elements:

a) **Nitrogen %** was determined by the modified micro Kjeldhal method as described by A.O.A.C. (1985).

b) **Phosphorus %** was determined by using Spekol spectrophotometer at the wave length of 882.0 nm according to the method described by Murphy and Riely (1962).

c) **Potassium %** was determined by using Flame photometer according to the procedure reported by Brown and Lilleland (1946).

3- Yield and fruit quality:

At maturity stage fruits of each tree (replicate) were separately harvested, then weighed and yield as kg/tree was estimated. Thereafter, 20 fruits per each tree were randomly selected for carrying out the following fruit quality measurements:

a) **Fruit physical characteristics:** Average fruit weight (g.); averages fruit dimensions (length and diameter in cm) by vernier caliper and fruit shape index (L/D ratio) were determined.

b) **Fruit chemical properties:** These were determined as follows:

b-1. Total soluble solids (TSS) %: by using a Carl-Zeiss hand refractometer according to the A.O.A.C. (1985).

b-2. Titratable acidity: as citric acid according to A.O.A.C. (1995).

b-3. The pulp content of vitamin C: (mg ascorbic acid/100g pulp) was determined by titration against 2,6 dichlorophenol indophenol according to A.O.A.C. (1995).

4- Statistical analysis:

Data recorded in two seasons were subjected to analysis of variance by MSTAT-C statistical package (MSTAT-C, 1990). Duncan's multiple rang test at the level of 5% was used according to Duncan (1955).

RESULTS AND DISCUSSION

1- Effect of bio and mineral N fertilizers on vegetative growth parameters:

It is quite evident as shown from tabulated data in Table (2) that, the four investigated growth parameters (average twig length; number of leaves; leaf area and leaves dry weight per twig) followed to great

Table 2

extent the same trend of response during both seasons. Herein, all mineral and bio N fertilization treatments (regardless of mineral and bio N fertilizer source applied solely or in combination) exceeded statistically the control treatment. Meanwhile, combinations representing the inoculation with any bacterial strain in addition to 500 gm mineral N/tree (regardless of the mineral N fertilizer source) were the most effective. However, both combinations of inoculation with (Bp) plus 500 gm N/ tree either as NH_4NO_3 or $(NH_4)_2$ SO_4 form tended relatively to surpass slightly the other bio- mineral N combinations in this concern. In addition, other combinations were in between the aforementioned two extremes with an obvious tendency proved the efficiency of bio-mineral combinations over other intermediate category. The enhancement of plant growth due to inoculation with symbiotic N-fixer could be attributed to the capability of these organisms to produce growth regulators such as auxins, cytokinines and gibberellins which affect the production root biomass and nutrients uptake.

The obtained result is in general agreement with the findings of Mansour (1998) on apple; Abd El-Aziz (2002) on banana plant cv. Williams; Srivastava *et al.*, (2002) on citrus; Sharma *et al.,* (2011) on mango.

2- Effect of bio and mineral N fertilizers on leaf mineral content:

Data in Table (3) reveal the effect of bio and mineral N- fertilizers on the percentage of N, P, and K in the leaves of Zebda mango trees during 2010 and 2011 seasons. It is obvious from the obtained data that application of N fertilization treatments proved that inoculation with any bio-fertilizers combined with mineral N fertilizer at 500 gm N/tree significantly increased leaf N, P and K contents. However, inoculation with AC + either NH_4NO_3 or $(NH_4)_2SO_4$ and inoculated Bp combined with NH_4NO_3 or $(NH_4)_2SO_4$ were statistically the superior N fertilization treatments during both seasons as leaf (K) and (N & P) contents were concerned, respectively. Such superiority may be attributed to that applying bio–fertilizers stimulate the living microorganisms in soil to work on the organic matter included and consequently convert the organic forms of some unavailable nutrients to an available mineral form that certainly reflected on increasing nutrients uptake. Data obtained are supported with those findings of Haggag and Azzazy (1996), on mango; Salama (2002), on Balady mandarin; Abd–Rabou (2006), on avocado and mango and Osman *et al.*, (2010), on olive.

3- Effect of bio and mineral N fertilizers on the yield and some physical characteristics:

Table (4) shows that yield; fruit weight; fruit dimensions and fruit shape index (length/diameter) didn't coincide in their response. Referring the specific effect of N fertilization treatments, Table (4) display that yield as kg/tree; fruit weight and fruit length followed typically the same trend of response. Hence, the highest values of both combinations between the three biofertilizers from one hand and 500 g N per tree regardless of the mineral fertilizer source. However, BP + $(NH_4)_2SO_4$ at 500 g. N/tree was the most effective followed by BP + NH_4NO_3; AL + either $(NH_4)_2SO_4$ or NH_4NO_3 and AC + $(NH_4)_2SO_4$ or NH_4NO_3. Nevertheless, both fruit diameter and fruit shape index, data obtained during both seasons displayed that the former one (diameter) followed to some extent the same trend previously detected with fruit length, while the later one (fruit shape index) had no linear trend regarding the response to various bio-mineral fertilizers. The variances in rates of response of two fruit dimensions (length and diameter) to a given N fertilization treatment directly reflected on the absence of firmer trend representing the response of fruit shape index. On the contrary, the control trees and those treated with mineral N fertilizers solely [$(NH_4)_2SO_4$ or NH_4NO_3] showed the least values of yield; fruit weight; fruit length and to great extent fruit diameter. However, other investigated bio-mineral N fertilization treatments were in between the aforesaid two extremes. The

Table 3

Table 4

stimulus effect of bio fertilizers application may be attributed to the promotion effect on the parameters of plant growth which are enable to absorb more minerals by its root system and thus reflected on the total fruit yields and its some physical properties. Findings of many investigators give a real support to our results Balakrishnan *et al*., (2001), on apple; Moustafa (2002), on orange; Abou-Grah-Fatma (2004), on Costata and Singh and Banik (2011), on mango.

4- Effect of bio and mineral N-fertilizers on some chemical characteristics:

Table (5) show the effect of bio and mineral N fertilizers on percentages of total soluble solids; total acidity and vitamin C content (mg/100 ml juice) of Zebda mango fruits during 2010 and 2011 seasons.

It is clear from the obtained data that using the mineral and bio N- fertilization treatments (regardless of mineral and bio N-fertilizer source applied solely or in combination) exceeded statistically the control treatment. Meanwhile, it was so clear that inoculation with BP + 500 g actual N as $(NH_4)_2SO_4$ treatment was the superior for improving chemical characteristics of the fruits in terms of increasing percentage of total soluble solids and vitamin C content and decreasing percentage of total acidity % during both seasons.

These results are in agreement with those obtained by Abd El-Aziz (2002) on Williams banana; Abd El-Hady (2003) on Flame seedless vines. Ahmed *et al*., (2003) on grapevines and mango trees; Abou-Grah-Fatma (2004) on persimmon; El-Kholy (2004) on banana and Singh and Banik (2011) on mango.

Table (5): Effect of bio and mineral N-fertilizers on TSS (%); acidity (%) and vitamin C content (mg/100 ml pulp) of Zebda mango cultivar during 2010 and 2011 seasons.

Treatment	TSS %		Acidity %		Ascorbic acid (V.C)	
	2010	2011	2010	2011	2010	2011
1- Ammonium nitrate (1000 g N/ tree)	14.00 cd	14.50 e	0.447 ab	0.433 ab	40.27 e	41.33 de
2- Ammonium sulphate (1000 g N /tree)	14.17 cd	14.60 de	0.403 a-c	0.400 a-c	41.33 b-e	42.40 de
3- Azospirillum lipoferum (Al)	15.00 bc	14.77 c-e	0.363 bc	0.373a-c	42.67 c-e	46.40 cd
4- Azotobacter chrococcum (AC)	14.50 cd	14.60 de	0.380 bc	0.373 a-c	42.40 c-e	43.20 de
5- Bacillus polymyxa (Bp)	16.17 ab	15.67 ab	0.340 bc	0.367 bc	46.13 b-d	51.20 bc
6- Al + Ammonium nitrate (at 500 g N/tree)	16.67 a	15.83 ab	0.340 bc	0.333 bc	47.93 bc	56.53 ab
7- Al + Ammonium sulphate (at 500 g N/tree)	15.33 bc	15.32 b-d	0.360 bc	0.360 bc	45.33 b-e	49.60 c
8- AC + Ammonium nitrate (at 500 g N/tree)	15.17 bc	15.00 c-e	0.360 bc	0.367 a-c	45.33 b-e	46.87 cd
9- AC + Ammonium sulphate (at 500 g N/tree)	16.83 a	16.07 a	0.320 c	0.317 c	50.40 ab	56.80 ab
10- Bp + Ammonium nitrate (at 500 g N/tree)	15.83 ab	15.30 bc	0.347 ab	0.357 bc	45.87 b-d	50.40 c
11- Bp + Ammonium sulphate (at 500 g N/tree)	16.83 a	16.13 a	0.320 c	0.310 c	52.80 a	59.73 a
12- Control	13.67 d	13.33 f	0.490 a	0.467 a	32.00 f	39.20 e

Means followed by a similar letter, within column, do not significantly differ at 0.05 level, Duncan's multiple rang test.

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تأثير التسميد النتروجينى الحيوى والمعدنى على نمو وصفات الثمار ومحصول أشجار المانجو

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الملخص العربى

أجريت هذه الدراسة على أشجار مانجو عمرها ٧ سنوات نامية فى مزرعة محطة بحوث البساتين بالقناطر الخيرية – محافظة القليوبية – مصر، خلال موسمين ٢٠١٠، ٢٠١١ لدراسة تأثير إضافة التسميد الحيوي بحقن التربة بأى من سلالات البكتريا الثلاث (أزوتوباكتر، أزوسبيريلم، باسيلاس) والتسميد المعدنى بنوعين من الأسمدة (نترات وسلفات أمونيوم) كل بمعدل ١٠٠٠ جم نتروجين صافى للشجرة فى اثنتا عشرة معاملة سمادية تمثل إضافة أى من مصادر السماد الحيوى أو المعدنى منفرداً أو تراكيب مختلفة بين الحقن بأى من سلالات البكتريا الثلاثة من جهة مع إضافة نصف الكمية من أى من نوعى السماد المعدنى (٥٠٠ جم نتروجين) من الجانب الأخر، إضافة إلى برنامج التسميد المتبع فى المزرعة كمقارنة.

ومن أهم النتائج المتحصل عليها كانت كالأتى:–

١– **القياسات الخضرية:** تفوقت معاملتى التسميد الحيوى بالحقن ببكتريا الباسيلاس مع إضافة ٥٠٠ جم نتروجين/شجرة سواء فى صورة نترات أو سلفات أمونيوم لتحقق أعلى قيم القياسات الخضرية (طول الفرع، عدد الأوراق لكل فرع، مساحة الورقة ووزن الأوراق الجافة).

٢– **المحتوى المعدنى:** التراكيب الأربعة الممثلة للحقن بأى من الأزوتوباكتر أو الباسيلاس من ناحية مع إضافة ٥٠٠ جم نتروجين صافى/شجرة فى صورة سلفات أو نترات أمونيوم أدت إلى زيادة المحتوى المعدنى للعناصر الغذائية – وإن تفوقت تراكيب الباسيلاس بالنسبة لكل من النتروجين والفوسفور بينما تفوقت تراكيب الأزوتوباكتر بالنسبة لمحتوى الأوراق من البوتاسيوم.

٣– **قياسات المحصول وصفات الثمار:** الحقن بالباسيلاس مع إضافة ٥٠٠ جم نتروجين صافى من سلفات أمونيوم/شجرة أعطت أكبر محصول وأعلى قيم لكل من وزن وطول وقطر الثمرة والمواد الكلية الذائبة وفيتامين ج وانخفاض قيمة دليل شكل الثمرة ونسبة الحموضة الكلية.

وعليه يمكن أن نوصى باستخدام التسميد الحيوى عن طريق الحقن بالأزوتوباكتر أو الباسيلاس مع إضافة ٥٠٠ جم نتروجين صافى فى صورة نترات أو سلفات أمونيوم لتسميد أشجار المانجو تحت الظروف المشابهة لنفس التجربة.

Table (2): Effect of bio and mineral N-fertilizers on some growth parameters of Zebda mango cultivar during 2010 and 2011 seasons.

Treatment	Shoot length (cm.)		Number of leaves/shoot		Leaf area (cm^2)		Dry weight (%)	
	2010	2011	2010	2011	2010	2011	2010	2011
1- Ammonium nitrate (1000 g N/ tree)	58.10 h	58.30 h	32.00 gh	34.00 e-g	85.8 e	90.3 b	40.3 d	41.7 b
2- Ammonium sulphate (1000 g N /tree)	58.50 h	58.90 h	33.00 fg	33.00 fg	96.6 de	93.4 b	41.4 d	42.5 b
3- Azospirillum lipoferum (Al)	59.60 g	60.10 g	35.00 ef	36.00 de	99.57 de	97.4 b	41.8 d	42.6 b
4- Azotobacter chrococcum (AC)	58.70 h	59.80 g	33.00 fg	35.00 ef	109.1 cd	98.1 b	41.6 d	43.3 b
5- Bacillus polymyxa (Bp)	62.80 cd	65.40 d	41.00 bc	42.00 b	114.0 cd	100.4 b	42.0 cd	43.5 b
6- Al + Ammonium nitrate (at 500 g N/tree)	63.20 c	66.70 c	42.00 b	42.00 b	118.8 bc	103.8 b	42.3 cd	44.4 ab
7- Al + Ammonium sulphate (at 500 g N/tree)	61.90 e	64.13 e	39.67 c	40.00 bc	124.0 bc	123.0 a	43.3 b-d	44.3 ab
8- AC + Ammonium nitrate (at 500 g N/tree)	60.50 f	62.90 f	37.00 de	38.00 cd	124.8 bc	126.2 a	45.4 a-c	44.3 ab
9- AC + Ammonium sulphate (at 500 g N/tree)	64.80 b	69.20 b	45.00 a	46.00a	133.0 ab	136.3 a	45.5 a-c	44.5 ab
10- Bp + Ammonium nitrate (at 500 g N/tree)	62.20 de	64.90 d	39.00 cd	41.00 b	133.5 ab	135.9 a	46.1 ab	44.7 ab
11- Bp + Ammonium sulphate (at 500 g N/tree)	67.30 a	72.70 a	46.00 a	48.00a	144.2 a	137.8 a	48.3 a	47.0 a
12- Control	55.40 i	56.73 i	30.00h	32.00 g	86.8 e	95.1 b	36.0 e	38.6 c

Means followed by a similar letter, within column, do not significantly differ at 0.05 level, Duncan's multiple rang test.

Table (3): Effect of bio and mineral N-fertilizers on N, P and K percentages of Zebda mango cultivar during 2010 and 2011 seasons

Treatment	N %		P %		K %	
	2010	2011	2010	2011	2010	2011
1- Ammonium nitrate (1000 g N/ tree)	1.333 de	0.967 c	0.147 f	0.167 e	1.520 cd	0.900 bc
2- Ammonium sulphate (1000 g N /tree)	1.333 f	1.033 c	0.160 d-f	0.167 e	1.490 cd	0.900 bc
3- Azospirillum lipoferum (Al)	1.333 de	1.067 bc	0.163 d-f	0.167 e	1.550 c	0.950 a-c
4- Azotobacter chrococcum (AC)	1.400 cd	1.167 bc	0.173 cd	0.173 de	1.553 c	0.950 a-c
5- Bacillus polymyxa (Bp)	1.433 bc	1.133 bc	0.167 de	0.170 de	1.557 c	0.933 a-c
6- Al + Ammonium nitrate (at 500 g N/tree)	1.400 cd	1.267 ab	0.187 bc	0.177 de	1.583 bc	0.983 ab
7- Al + Ammonium sulphate (at 500 g N/tree)	1.400 cd	1.167 bc	0.187 bc	0.183 c-e	1.587 bc	1.000 ab
8- AC + Ammonium nitrate (at 500 g N/tree)	1.467 a-c	1.300 ab	0.177 cd	0.200 bc	1.790 a	1.017 a
9- AC + Ammonium sulphate (at 500 g N/tree)	1.433 bc	1.300 ab	0.187 bc	0.187 cd	1.787 a	1.033 a
10- Bp + Ammonium nitrate (at 500 g N/tree)	1.533 a	1.467 a	0.207 a	0.220 a	1.723 ab	1.000 ab
11- Bp + Ammonium sulphate (at 500 g N/tree)	1.500 ab	1.400 a	0.203 ab	0.210 ab	1.627 bc	0.1000 ab
12- Control	1.267 e	0.967 c	0.150 ef	0.147 f	1.390 d	0.867 c

Means followed by a similar letter, within column, do not significantly differ at 0.05 level, Duncan's multiple rang test.

Table (4): Effect of bio and mineral N-fertilizers on yield (kg/tree); fruit weight (g.); fruit length; diameter (cm) and fruit shape index of Zebda mango cultivar during 2010 and 2011 seasons.

Treatment	Yield kg/tree		Fruit weight (g.)		Fruit length (cm)		Fruit diameter(cm)		Fruit shape index	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
1- Ammonium nitrate (1000 g N/ tree)	138.4 cd	144.3 f	401.5 d	481.0 de	16.11 de	16.67 cd	8.55 d	8.85 ef	1.88 b	1.88 b
2- Ammonium sulphate (1000 g N /tree)	140.8 cd	155.1 e-g	407.8 cd	489.7 de	16.09 de	16.56 d	8.50 d	8.90 d-f	1.87 cb	1.86 cb
3- Azospirillum lipoferum (Al)	157.0 c	158.5 ef	440.1 b	462.5 fg	16.21 de	16.86 cd	8.77 b-d	8.16 de	1.85 c	1.84 c
4- Azotobacter chrococcum (AC)	146.3 cd	156.8 e-g	422.0 c	482.0 de	16.14 de	16.82 cd	8.65 cd	8.95 df	1.86 c	1.88 b
5- Bacillus polymyxa (Bp)	187.9 b	171.1 e	476.9 ab	478.9 ef	16.32 c-e	16.93 cd	8.83 b-d	9.24 cd	1.85 c	1.83 c
6- Al + Ammonium nitrate (at 500 g N/tree)	218.7 a	231.9 bc	478.9 ab	553.1 ab	17.09 ab	18.32 a	9.01 a-c	9.58 bc	1.90 b	1.91 a
7- Al + Ammonium sulphate (at 500 g N/tree)	224.0 a	240.8 ab	471.3 ab	548.9 ab	16.90 bc	17.86 a	9.04 ab	9.66b	1.87 cb	1.85 cb
8- AC + Ammonium nitrate (at 500 g N/tree)	190.50 b	206.8 d	470.0 ab	527.6 cd	16.86 bc	17.85 ab	8.85 b-d	9.25 cd	1.90 b	1.91 a
9- AC + Ammonium sulphate (at 500 g N/tree)	214.1 a	213.9 cd	482.2 ab	534.8 c	16.66 b-d	17.38 bc	9.00 a-c	9.26 cd	1.85 c	1.88 b
10- Bp + Ammonium nitrate (at 500 g N/tree)	226.6 a	249.1 ab	472.8 ab	558.5 a	17.22 ab	18.32 a	9.24 a	9.72 b	1.86 c	1.88 b
11- Bp + Ammonium sulphate (at 500 g N/tree)	232.8 a	259.0 a	485.0 a	568.0 a	17.64 a	18.36 a	9.30 a	10.05 a	1.90.b	1.63 c
12- Control	129.0 d	132.0 g	380.9 d	441.9 g	15.89 e	16.46 d	8.08 e	8.76 f	1.96 a	1.88 b

Means followed by a similar letter, within column, do not significantly differ at 0.05 level, Duncan's multiple rang test.