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RESPONSE OF ZEBDA MANGO TREES TO ORGANIC AND BIO NITROGEN FERTILIZATION AS A PARTIAL SUBSTITUTE FOR MINERAL NITROGEN

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ABSTRACT

The present study was executed in 2014 and 2015 seasons on 23-year-old Zebda mango trees grown in sandy soil under drip irrigation system at the experimental orchard of El-Kassasien Hort. Res. Station, Ismailia Governorate. This investigation aimed to study the possibility of using the organic nitrogen (chicken manure 3.21 % N) with bio nitrogen (biogen) fertilizers partially instead of completed mineral nitrogen (ammonium sulphate 20.6 %N).

Results revealed that reducing the percentage of mineral nitrogen from 100 % to 25 % and increasing organic nitrogen to 75 % with bio-fertilizers (100 g biogen /tree) had an announced promotion and increasing number and length of new shoots, number of leaves/ shoot , leaf area, N,P and K contents, number of initial and retention fruit set percentage and yield (kg/tree). Fruit weight and pulp firmness, TSS and vitamin C content were also increased. While, fruit peel thickness and juice acidity percentage were significantly decreased in comparison with the control treatment (100 % mineral N).

***Conclusively,** under the conditions of this study, 75 % of organic nitrogen (23.36 kg chicken manure/tree) + 25 % mineral nitrogen (1.21 kg ammonium sulphate/tree) with biogen bio-fertilizer at 100 g /tree was sufficient for minimizing mineral nitrogen fertilization to the quarter and increasing yield/tree by 41.50 % (average of the two seasons) with the best fruit quality of Zebda mango as compared with control treatment.*

Key words : Zebda mango, ammonium sulphate, chicken manure, biogen, yield and fruit quality.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the important fruit crops in tropical zones of the world and Egypt. In Egypt, it considered the most popular fruit crop and occupies the second rank place in area after citrus.

The total acreage of mango reached about 240804 fed.; out of them 183341 fed. are fruit full producing about 786528 tons with an average of 4.28 tons/fed. according to Ministry of Agric. statistics, 2012. Common problems face and affect mango productivity are poor fruit set and high fruit drop percentages at different fruit growth stages in addition to alternate bearing habit.

The nitrogen fertilization is an important factor for growth and productivity of mango trees, specially Zebda cv.

Application of organic manure has numerous merits such as reducing soil pH and salinity and increasing the availability of all nutrients, as well as enhancing soil organic matter, cation exchange capacity and fertility in addition to biological activity, formation of natural hormones , antibiotics , vitamins B and developments of roots (Nijjar, 1985; Russo and Berlyn, 1990 and Dahama, 1999).

Biofertilization are benefit in enhancing biological activity due to its higher own from microorganisms . It is responsible in suppresses plant pathogens and diseases, conservation of energy in plants, solublization of minerals in the soil and promotion of photosynthetic efficiency and biological N fixation (Higa and Wididana, 1991; El-Haddad *et al*., 1993; Myint , 1999 and Kannaiyan, 2002).

Previous studies emphasized that using the suitable N form through inorganic , organic and bio fertilization was preferable rather than using mineral N fertilization alone in enhancing soil fertility, growth, yield and fruit quality of all evergreen fruit crops particularly mangoes, bananas , date palms and citrus (Moustafa, 2002; Gabara and Ahmed, 2004; Mansour *et al*., 2004, Mohamed and Ragab, 2004; Roshdy, 2004; El-Assar, 2005, Shaarawy, 2005; Diab, 2006; Mouftah, 2007; Abdo, 2008; Al-Wasfy and El-Khawaga, 2008; El-Salhy, 2008; Mahmoud, 2008, Sayed, 2008; Shaalan, 2008; Morsi , 2009; Shaheen *et al*., 2009; Ibrahim, 2010; Mahfouz , 2011; Saad *et al*., 2011; Abdelaal *et al*., 2012; El-Khawaga, 2012; Ibrahim, 2012; Mahmoud, 2012; Farag, 2013 and Al-Wasfy and Abd El-Rahman, 2014).

Therefore, the objective of this study was examining the effect of replacing mineral N fertilizer partially using chicken manure as an organic N fertilizer and biogen as bio-N fertilizer on fruit set, yield and fruit quality of Zebda mango trees grown in sandy soil.

MATERIALS AND METHODS

The present investigation was carried out during the three consecutive seasons of 2013, 2014 and 2015 (the first season considered as

a preliminary trail) on 23 -year –old Zebda mango trees (*Mangifera indica* L.) grafted on seedling rootstock. The trees were planted at 7 m apart in sandy soil and drip irrigated using a moderate saline irrigation water (780 ppm) in the experimental orchard of El-Kassasien Hort. Research Station, Ismailia Governorate.

At the beginning of this investigation 21 trees were selected for nearly similar size and being in their off-bearing year in the previous season. The experimental trees were healthy and uniform in vigor, shape and free from bests infestation. The orchard soil analyses are given in Table (A) according to Wilde *et al*. (1985).

Table (A). Some physical and chemical analysis of the orchard soil

Physical properties	(%)	Chemical properties	Value
Field capacity	11.77	$CaCO_3$ (%)	12.25
Available water	1.55	Organic matter (%)	0.48
Wilting point	4.20	pH (1:2.5 extract)	7.75
Coarse sand	67.80	E.C. (1:2.5 extract, mhos/1cm)	1.21
Fine sand	19.00	N (mg/ kg)	84.00
Silt	8.00	P (mg/kg)	8.00
Clay	5.20	K (mg/kg)	117.00
Texture grade	Sandy		

The treatments were arranged in a randomized complete design, the experiment includes seven treatments, each contains three replicates and the replicate represented by one tree. The normal agriculture practices that used in the orchard were applied to all experimental trees, except those dealing with nitrogen fertilization. Mango tree require 1000 g actual nitrogen yearly according to the recommendations of Ministry of Agriculture, Egypt. The recommended rate of N was applied through three sources of N as follows:

(1) Mineral source of N namely ammonium sulphate (20.6 % N) which was applied at fourteen equal doses weekly starting at the third week of Feb. and through March, May and June (Mansour and Shaaban, 2007) found that, the best source of mineral N applied with organic and bio biofertilizers were ammonium sulpahte).

(2) Organic source of N namely chicken manure (3.21 % N) was added once in a circle around each tree at the second week of Jan., then covered with the soil and irrigated (Fayed, 2010 indicated that chicken manure as a rule the best and foregoing of the organic fertilizers).

(3) Biogen as a bio- fertilizer contain Azotobacter and Azospirillum bacteria N fixing bacteria was applied at same place of potting chicken manure at the first week of Feb. with constant rate 100 g /tree, then covered with the soil and irrigated.

The chemical composition of the tested chicken manure are shown in Table (B).

Table (B). Some chemical characteristics of the chicken manure

Parameters	**Values**
Cubic meter (kg)	535.0
Moisture (%)	12.52
Organic matter (%)	52.78
Organic carbon (%)	34.70
pH	7.12
C/N ratio	10.80
Total N (%)	3.21
Total P (%)	0.65
Total K (%)	1.19

The seven N fertilization treatments involved in this study was arranged as follows:

T_1- 100 % mineral nitrogen fertilization (1000 g N/tree)* via ammonium sulphate (4.85 kg/tree) as a control.

T_2- 100 % organic fertilization via chicken manure (31.15 kg/tree).

T_3- 100 % organic via chicken manure (31.15 kg/tree) with bio-nitrogen fertilization via biogen (100g/tree).

T_4- 75 % organic via chicken manure (23.36 kg/tree) + 25 % mineral via ammonium sulphate (1.21 kg/tree).

T_5- 75 % organic via chicken manure (23.36 kg/tree)+ 25 % mineral via ammonium sulphate (1.21 kg/tree) with biogen (100g/tree).

T_6- 50 % organic via chicken manure (15.58 kg/tree)+ 50 % mineral via ammonium sulphate (2.43 kg/tree).

T_7- 50 % organic via chicken manure (15.58 kg/tree)+ 50 % mineral via ammonium sulphate (2.43kg/tree) with biogen (100g/tree).

* Those treatments represents the recommended rate of actual nitrogen of tree.

The following parameters were recorded:-

Vegetative characteristics:

At the beginning of each growth season (early March) one –year-old nine vegetative branches, were randomly chosen and marked on each

tree to determine the number of newly formed shoots per twig, length (cm) and number of leaves per shoot at the end of each season (late of Sept.). The average leaf area (cm^2) was estimated on five mature leaves for each replicate detached from the medium portion of the tagged shoots starting from the third leaf using a Ci-203 area meter CID, Inc (USA).

Leaf macro elements contents

Leaf samples were taken in October from the middle position of current season shoots. The leaves were cleaned then dried at 70 ^oC and digested with sulphuric and perchloric acids(3:1 v/v) . The leaf nitrogen content was determined according to the micro Kjeldahl method as described by Black (1965), phosphorus was determined spectrophotometrically as described by John (1970) and potassium content was flamephotometrically determined according to the method of Jackson (1965). The leaf NPK contents were expressed as percentage on dry weight basis.

Fruiting parameters:

At full bloom 40 panicles / tree distributed at the four directions were of each tree chosen at random and tagged. The following parameters were determined: Number of initial fruit set / panicle (15 days after petal fall), number of retained fruits/panicle (at harvest) and percentage of retained fruits at harvest (percentage of retained fruits = average number of retained fruits per panicle at harvest / average number of initial fruit set per panicle x100).

Harvest was achieved during the regular commercial harvest time under Ismailia Governorate conditions (mid of August) in both seasons when the flesh of fruits become yellowish.

Yield/ tree (kg): Yield / tree was estimated at harvest by multiplying the number of fruits born on each tree **x** average fruit weight.

Fruit quality:

Samples of five mature fruits per tree were randomly chosen and kept in the laboratory till ripe stage. The following fruit quality parameters were assessed : Fruit weight (g), peel thickness (mm) by a vernier caliper, flesh firmness ($Lb/inch^2$) using penetrometer (pressure tester), juice total soluble solids TSS (Brix) using an Abb. digital refractometer, juice total acidity percentage as citric acid was measured according to (A.O.A.C., 1995) and vitamin C content was determined by titration with dichlorophanol indophenol blue dye (expressed as mg/100 ml juice).

Statistical analysis:

The obtained data were tabulated and statistically analyzed according to Snedecor and Cochran (1991) and means separation was done according to Duncan (1955) at 0.05 levels of probability.

RESULTS AND DISCUSSION

Vegetative characteristics:

Results in Table (1) illustrate that vegetative growth parameters , i.e., number of new shoots per twig , shoots length, number of leaves per shoot and leaf area were significantly affected by the applied fertilizers treatments in both seasons of study.

It was found that Zebda mango trees receiving 75 % organic nitrogen (ON) +25 % mineral nitrogen (MN) with bio nitrogen (BN) recorded the highest values of these parameters, followed in a descendingly order by 50 % ON +50 % MN with BN and 100 % ON with BN treatments, respectively. The least values were gained by control, treatment other treatments were in between range. The positive effects of organic manure on the vegetative characteristics could be attributed to their effects on supplying the trees with their requirements of various nutrients as a relatively long times, as well as, their effect on lowering soil pH which could aid in facilitating the availability of some nutrients in the soil and improving physical characters of the soil in favor of root development (Gamal and Ragab, 2003). However, Abou El-Khashab, (2002) reported that, the enhancement of plant growth due to inoculation with N-fixing bacteria could be attributed to the capability of these organisms to produce growth regulators such as auxine, cytokinins and gibberellins which affect production of root biomass and nutrients uptake.

These results are in agreement with those reported by El-Morshedy (1997) on sour orange, Abdel El-Naby and Gomaa, (2000) on banana, Maksoud, (2000) on olive, Helial *et al*. (2003) on Washington navel orange trees, Abde EL-Naby and El-Sonbaty (2005) on banana, Hegazi *et al.* (2007) on picual olive trees and Osman and Abd El-Rhman (2010) on fig trees.

Leaf N, P and K contents:

Data in Table (2) indicate that leaf nitrogen (N), phosphorus (P) and potassium (K) contents were significantly affected by different tested treatments during the two seasons. The highest percentages of N, P and K were gained by 75 % ON+25 % MN with BN without significant differences between 50 % ON+50 % MN with BN and 100 % ON with BN treatments concerning N and K in both seasons. While 100 % MN (control) and other

treatments recorded the least percentages without significant differences between them except few cases in both seasons.

The outstanding role of organic fertilization on reducing the loss of nutrients through drainage water could explain the present results. Similar findings were reported by Nijjar (1985), El-Hady *et al.* (1991), El-Sayed (1994), Kassem and Marzouk (2002), Lopez-Granados *et al*. (2004), Hegazi *et al*. (2007) , Morsi (2009) and Shaheen *et al*.(2013) who found that adding organic manure increased leaf minerals content due to availability of nutrients in the soil, resulting in more available nutrients to plant uptake. However, El-Kramany *et al*. (2000) found that, bio-fertilizers help in availability of minerals and their forms in the composted material and increased levels of extractable N, P and K.

It is clear from Table (3) that the number of initial fruit set per panicle reached its highest values due to applying 75 % ON +25 % MN with BN followed by 50 % ON +50 % MN with BN and 100 % ON with BN treatments in descendingly order. The lowest values were recorded by 100 % MN (control), the other treatments gained intermediate values in both experimental seasons.

As shown in Table (3) the retained fruits at harvest, fruit retention percentage and yield (kg/tree) of Zebda mango fruits were significantly affected by the tested N treatments during both seasons. The highest values of all parameters were recorded by application 75 % ON +25 % MN with BN treatment followed by the other treatments with significant differences between them. The lowest values were achieved by 100 % MN (control) in both seasons. Fruit yield (kg/tree) was increased in the second season than in the first one, mainly due to accumulation effects of organic fertilization treatments.

The relative increases in fruit yield /tree was about (39.68 and 43.33 %) due to the application of 75 % ON +25 % MN with BN as compared with control treatment both seasons, respectively.

These results are in agreement with those obtained by Abou-El-Khashab *et al.* (2005), Fayed (2005), El-Rawy (2007), Hegazi *et al.* (2007), Mostafa (2008), Mohammed *et al*. (2010), Uwakiem (2011) and Shaheen *et al.* (2013).

Fruit physical properties:

As shown in Table (4) all of the conducted treatments significantly increased the average fruit weight and pulp firmness compared with control one in both seasons. The heaviest fruit weight was recorded for 75 % ON + 25% MN with BN treatment as compared with the other treatments with

significant differences between them in the two seasons. These findings are in harmony with those obtained by Fouad *et al*., (2002), Sharawy (2005) and Osman and Abd El-Rhman (2010) for fruit weight and Alaa El-Din and El Sayed (2007) concerning mango fruit pulp firmness.

Fruit peel thickness was affected by the conducted treatments. The thickset peel was recorded for fruits of control treatment (100 % MN) in the first and second seasons. It is noticed that, treatments included organic and bio-fertilizers tended to decrease peel thickness. These results confirmed those of Abd El-Migeed *et al.* (2007).

Fruit chemical characteristics:

It is apparent from Table (5) that fruit chemical properties, i.e., total soluble solids, titratable acidity, TSS/acid ratio and vitamin C content were significantly affected by N fertilization treatments in the two seasons of this study. The highest percentages of total soluble solids and TSS/acid ratio and the lowest acidity percentage were found in fruits of trees receiving 75 % ON +25 % MN with BN compared with 100 % MN treatment (control) in both seasons. The other treatments gained intermediate percentage with significant differences between them. These results are in accordance with those reported by El-Sawy (2005); Alaa-El-Din and El-Sayed (2007); Mouftah (2007); Ahmed *et al*. (2011) and El-Khawaga (2012).

Regarding vitamin C content, results show significant differences in both seasons of study. The superiority was recorded for 75 % ON+25 % MN with BN treatment with significant differences with the other treatments. Meanwhile the lowest content was gained through applying 100 % MN treatment (control) in the two seasons. Similar results were reported by Moustafa (2002), Salama (2002); Abd El-Migeed *et al*., (2007) and Alaa-El-Din and El-Sayed (2007).

Conclusively the gradual increase of organic nitrogen doses with decreasing the dose of mineral nitrogen gave the highest significant increase of TSS, TSS/acid ratio and the lowest total acidity percentage of Thompson Seedless (Belal, 2006). Also, El-Naggar (2004) showed that biofertilizers is favorable in improving nutritional status of the vines, yield , physical and chemical properties of grapevines. El-Rawy (2007) stated that replacing 50-75 % of N requirements for grapevine fruits by organic manures improved berry quality.

The promoting effect of organic and biofertilization on fruit quality was attributed mainly to their essential role in enhancing organic foods

especially total carbohydrates and plant pigments which is reflected on advancing fruit maturity (Nijjar, 1985).

Conclusively, under the conditions of this study, 75 % of organic nitrogen (23.36 kg chicken manure/tree) + 25% mineral nitrogen (1.21 kg ammonium sulphate / tree) with biogen bio-fertilizer at 100 g /tree was sufficient for minimizing mineral nitrogen fertilization to the quarter and increasing yield/tree by 41.50 % (average of the two seasons) with the best fruit quality of Zebda mango as compared with control treatment.

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إستجابة أشجار المانجو صنف زبدة للتسميد النيتروجينى العضوى والحيوى كبديل جزئى للنيتروجين المعدنى

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أجريت هذه الدراسة خلال موسمى ٢٠١٤-٢٠١٥ على أشجار المانجو صنف زبدة عمر ٢٣ سنة النامية فى تربة رملية تحت نظام الرى بالتنقيط بالبستان التجريبى لمحطة بحوث البساتين بالقصاصين - محافظة الإسماعلية . بهدف دراسة إمكانية إستخدام السماد النيتروجينى العضوى (سماد الدواجن ٣,٢١ %ن) مع السماد الحيوى (البيوجين) كبديل جزئى للنيتروجين المعدنى (سلفات الأمونيوم ٢٠,٦ % ن).

أوضحت النتائج أن تقليل نسبة النيتروجين المعدنى من ١٠٠% من المعدل الموصى به إلى ٢٥ % مستكملا بإضافة ٧٥ % نيتروجين عضوى مع السماد الحيوى أحدث تفوقا معنويا فى زيادة عدد وطول الأفرع الحديثة ، عدد الأوراق/الفرع ومساحة الورقة بالإضافه إلى محتواها من عناصر النيتروجين ، الفوسفور والبوتاسيوم ، كما أدت إلى زيادة نسبتى العقد المبدئى ، الثمار المتبقية ومحصول الشجرة بالكيلو جرام وكذلك وزن الثمرة ، صلابه اللب ، ومحتواه من المواد الصلبة الكلية الذائبة وفيتامين ج – مع إنخفاض سمك القشرة وحموضة العصير مقارنة بمعاملة المقارنة (١٠٠ % نيتروجين معدنى).

التوصية: من نتائج هذه الدراسة إتضح أن تسميد أشجار المانجو بالسماد العضوى (سماد الدواجن) بنسبه ٧٥ % من المعدل الموصى به (٢٣,٣٦ كجم سماد دواجن/ شجرة)+٢٥ % نيتروجين معدنى (١,٢١ كجم سلفات أمونيوم/شجرة) مع السماد الحيوى (١٠٠ جم بيوجين/شجرة) كانت هى الأكثر فاعليه فى تقليل إستخدام السماد النيتروجينى المعدنى إلى الربع حيث أدت إلى زيادة المحصول بنسبه ٤١,٥ % (متوسط الموسمين) وتحسين جودة ثمار المانجو صنف زبدة عن معاملة المقارنة .