American Journal of Agriculture and Forestry
2016; 4(6): 163-167
http://www.sciencepublishinggroup.com/j/ajaf
doi: 10.11648/j.ajaf.20160406.14
ISSN: 2330-8583 (Print); ISSN: 2330-8591 (Online)

Agricultural Production: Improving "Dabsha" Mango Trees Productivity and Fruit Quality by Biological Fertilizers

Ahmed Fathallah El-Shiekh[1, 2]

[1]Dibba Experiment Station, Ministry of Environment & Water, Dibba, Fujairah, UAE

[2]Horticulture Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt

Email address:
afelshiekh@hotmail.com

To cite this article:
Ahmed Fathallah El-Shiekh Dibba. Agricultural Production: Improving "Dabsha" Mango Trees Productivity and Fruit Quality by Biological Fertilizers. *American Journal of Agriculture and Forestry.* Vol. 4, No. 6, 2016, pp. 163-167. doi: 10.11648/j.ajaf.20160406.14

Received: October 24, 2016; **Accepted**: December 13, 2016; **Published**: January 13, 2017

Abstract: Bio-fertilizers are used to improve the fertility of the land using biological wastes, hence the term bio-fertilizers and biological wastes do not contain any chemicals which are detrimental to the living soil. This study was done at Dibba Experiment Station, Eastern Region, Ministry of Environment & Water, UAE to study the effect of two types of biological fertilizers (Alnawaya and Super Alnawaya) on "Dabsha" mango trees productivity and fruit quality. The bio-fertilizers were applied at two different doses (25 Kg/tree and 50 Kg/tree) and were added in a powder form to 20 year-old mango trees. These fertilizers are formed from balanced organic manure enriched with 0.5% special marine and decomposed microbes "SUPERBAN" were added. Trees supplemented with Super Alnawaya biological fertilizer at both doses had higher yield than the control and the Alnawaya (25 kg/tree) treatments with no significant differences between the rest of the treatments. Super Alnawaya fertilizer (25 Kg/tree) increased tree yield by about 88% compared with the control in the second season and the yield increment was over 100% in the first season. In the first season, Alnawaya fertilizer increased fruit pulp (%) significantly over that of the control while in the second season, Super Alnawaya (25 Kg/tree) increased fruit pulp (%) significantly over that of the high dose of Super Alnawaya. Fruit firmness and soluble solids content (SSC) were reduced by all treatments in comparison with the control treatment, in the first season only. In both seasons, leaves mineral contents did not change radically by the treatments. Therefore, Super Alnawaya (25kg/tree) fertilizer is recommended for 20 year-old "Dabsha" mango trees growing in coarse soil under the UAE subtropical environment.

Keywords: Mangifera Indica L., Alnawaya and Super Alnawaya Fertilizers, Yield, Quality, Minerals

1. Introduction

Mango is an important tropical fruit, ranking the 5th amongst fruit production and consumption worldwide (Xiuchong et al., 2001). Mango fruits are popular among the consumers and have high commercial value (Rahayu et al., 2013). The leading mango producers in the world are India, China, Mexico and Thailand (FAO, 2003). Fertilization of mango orchard is critical to obtain satisfactory mango yield. Recommendations for nitrogen (N) supply indicate that 400g N/tree/year is needed for acceptable commercial yield (Chia et al., 1988, Wanitprapha et al., 1991, Cran and Campbell, 1994 and Santos, 2007). Nitrogen amounts could be increased depending on tree size and site conditions. In sandy soils, fertilization practices raise environmental concerns about rapid N leaching to ground waters (Schumann et al., 2003). Introduction of mineral fertilizer led to improve tree yield. However, after sometime, chemical fertilizers started to display their harmful-effect such as polluting underground water, destroying micro-organisms and friendly insects, causing the crop to become more susceptible to diseases, reducing soil fertility and thus causing permanent damage to the overall system. Over fertilization may pollute ground water, reduce profit margins, induce deficiency of other elements and also decrease yield (Shamseldin et al., 2010). According to the ill effects of long and exclusive use of mineral fertilizers and consistent growing demand from the consumers for fruit quality, coupled with unsustainable productivity of mangoes, many studies have started to find some alternative cultural practices to minimize the uses of chemical fertilizers. Organic culture is claimed to be the

alternative for chemical fertilizers in coarse textured soils (Dubey and Yadav et al., 2003). Organic matter helps to hold water on the soil surface long enough for it to leak slowly into the soil, improves soil physical condition, helps to provide better aggregation and structure and lowering bulk density (Moyin-Jesu and Adeofun, 2008). Organic matter is a source of phosphorus and carbon stimulating microflora population and also provides sites for the microflora to colonize bacteria secrets enzymes which act as catalyze liberating calcium and phosphorus from insoluble calcium phosphate, also, liberating iron and phosphorus from insoluble iron phosphate. It was reported that organic fertilization increased N, P, K, Ca and Mg content in mango seedling leaf and soil relative to the control treatment (Subba-Rao, 1984). Besides, it was found that the addition of compost for 2 years increased orange fruit number by averages of 17 and 24% in comparison with the same treatments without compost (Schumann et al., 2003).

Bio-fertilizers, which are a form of organic fertilizer, are used to improve the fertility of the land using biological wastes. They are extremely beneficial in enriching the soil with micro-organisms, which produce organic nutrients for the soil and help fight diseases. Bio-fertilization is considered an important tool to enhance yield and fruit quality of mangoes and it becomes a positive alternative to chemical fertilizers. The bio-fertilizers are termed to be safe for human, animal and environment and using them was accompanied with reducing the pollution occurred to the environment as well as for producing organic foods (Subba-Rao, 1984 and Subba-Rao, 1993). According to Dubey and Yadav (2003), bio-fertilizer improved fruit quality as well as yield, fruit weight, soluble solids content (SSC) and juice volumes of mandarin. In the same direction, Mansour and Shaaban (2007) studied the effect of organic and/or bio-fertilizer and noticed improvements in vegetative and nutritional status of oranges. In addition, Farag (2006) reported that organic fertilizers significantly decreased nitrogen as nitrate and nitrite content and improved yield and fruit quality of grape vines.

Therefore, and because of the scarce information about using the biological fertilizers on mangoes grown in the UAE, the objective of this study was to assess the influence of some local bio-fertilizers on 'Dabsha' mango yield and fruit quality.

2. Materials and Methods

The study was carried out at Dibba Experiment Station, Fujairah, Ministry of Environment & Water, UAE (subtropical environment), during two successive seasons (2010/2011 and 2011/2012). Two different types of local biological fertilizers (Alnawaya and Super Alnawaya) were tested. Biological fertilizers were obtained from Emirates Bio-Fertilizer Factory, UAE. These fertilizers were applied to the soil at about 25 cm depth and mixed thoroughly around the trees. The chemical parameters of the bio-fertilizers are shown in Table 1.

Table 1. *Chemical parameters of the bio-fertilizers used in the study.*

Type of bio - fertilizer	g Kg^{-1}						
	N	P	K	Ca	Mg	S	Organic matter
Alnawaya	20-30	20-30	20-30	10-20	5-10	5-7	500-550
Super Alnawaya	20-30	20-30	30-40	10-20	5-10	5-7	500-550

Alnawaya and Super Alnawaya fertilizers were used at two different levels (25 Kg/tree and 50 Kg/tree) on 20-year-old "Dabsha" mango trees spaced at 8×8 m and planted in a coarse textured soil. Alnawaya fertilizer (25 Kg/tree) supplies the soil of each tree with the following: 500-750 g N + 500-750 g P + 500-750 g K + 250-500 g Ca + 125-250 g Mg + 125-175 g S + 12.5 13.75 Kg organic matter. In addition, Super Alnawaya (25 Kg/tree) supplies the soil for each tree with the same amount of minerals as before except for the K which was 750-1000 g. Both Alnawaya and Super Alnawaya bio-fertilizers were used in powder form. These fertilizers were enriched with 0.5% special marine, 200 *ppm* of manganese and iron in addition to 800-1000 *ppm* of zinc, copper, molybdenum and boron and decomposed microbes "SUPERBAN" were added. Besides, inorganic fertilizers (regular fertilizer program in the orchard; 1500 g N + 750 g P + 1500 g K/tree/year) were used for comparison. Also, control (no fertilizers) trees were assigned to the research plan. Total of 30 uniform-vigor trees were chosen (6 treatments × 5 replicates; randomized complete block design).

At maturity, fruits from each replicate of each treatment were hand harvested and transferred at ambient temperature to the lab within 15 min and sorted to eliminate defects. The entire harvest from each tree was weighed. Fifteen fruits from each replicate were selected for uniform size, washed only with water, dried, labeled and individually weighed. Also, fruit dimensions (length & width; cm) were recorded using a vernier caliper. At firm ripe stage, fruit firmness, acidity and soluble solids content (SSC), were evaluated.

2.1. Firmness

Penetration force for the fruit after peeling was determined by measuring the force required for a 7-mm probe to penetrate the pulp (midpoint between endocarp and skin). The fruit was held perpendicular to the probe and the probe penetrated to a depth of 1 cm using Effegi penetrometer (McCormick, Yakima, Washington). Penetration force for the fruit was measured on two opposite sides and the average force was recorded for each fruit replicate and expressed by Newton (N; El-Shiekh and Burshaid, 2010).

2.2. Pulp Percentage

It was calculated from the following equation:

% pulp = (pulp weight/fruit weight) × 100 (El-Shiekh and Burshaid, 2010).

2.3. Chemical Evaluations

Soluble solids content (SSC) and acidity were determined using the procedures of Drake et al. (1981). From each fruit, 20 g of pulp were homogenized in 80 ml distilled water for

one min. A disposable pipette was used to transfer 1 ml of homogenate onto a Milton Roy (Japan) hand-held refractometer for SSC (%) measures. Fifty ml of homogenate was put in a 100 ml beaker, stirred and titrated to pH 8.1 with 0.1N NaOH. Acidity was reported as citric acid (%).

To determine leaf minerals content, forty leaves were collected from each tree replicate in December of each season from the middle of non-fruiting 6-month-old growth cycle Jones and Embleton (1960). Leaves were taken from the tree at height of 50 – 150 cm above ground. Samples were sent to the Central Lab, Ministry of Environment & Water, for analysis. Leaves macro nutrients assay was done using the AOAC (1998).

2.4. Statistical Analysis

The fertilizers were mixed with the coarse soil at 25 cm depth from the ground surface for each tree replicate. The experimental design was completely randomized block. Analysis of variance (one-way analysis; ANOVA) and means comparisons (LSD, 5%) were performed using Statistix 4.1 (Analytical Software, Inc., Tallahassee, FL) program.

3. Results

From Table 2, it is obvious that 'Dabsha' mango trees yield increased significantly by Alnawaya (50 kg/tree) and Super Alnawaya (both doses) treatments compared to the control (in the first season). No significant differences were noticed between the control and Alnawaya (25 kg/tree) treatments. However, in the second season (Table 3), Super Alnawaya (25 kg/tree) and mineral fertilizer treatments resulted in a significantly higher yield than the rest of the treatments. No significant differences were recorded in yield between Super Alnawaya (25 kg/tree) and the mineral fertilization in both seasons.

Table 2. *Effect of mineral and bio-fertilizers on yield, fruit weight and quality of "Dabsha" mango (first season; 2010/2011).*

Treatments	Yield (Kg/tree)	Fruit weight (gm)	Pulp (%)	Fruit firmness (N)	[1]SSC (%)	Acidity (%)
Alnawaya (25Kg)	50.5	541.4	77.6	7.9	17.5	0.78
Alnawaya (50Kg)	72.3	548.8	77.9	10.1	16.1	0.73
[2]SA (25Kg)	67.4	539.3	75.1	10.9	16.7	0.83
SA (50Kg)	82.1	503	76.3	9.3	14.9	0.75
[3]Mineral fertilizer	81.7	616.1	75	8.25	17	0.70
Control	19.7	477.7	72.6	11.6	17.8	0.80
LSD (0.05)	32.4	100.4	3.7	2.68	2.13	0.15

[1]Soluble solids content
[2]SA = Super Alnawaya
[3]1500g N + 750g P + 1500g K/tree/year

In the first season only, mineral fertilizer increased average fruit weight over that of the control (Table 2). However, no significant differences were noticed in fruit weight as a result of Alnawaya or Super Alnawaya treatments in both seasons (Tables 2 & 3). In addition, in the first season (Table 2), Alnawaya fertilizer increased fruit pulp (%) over that of the control with no significant differences between Alnawaya, Super Alnawaya and mineral fertilizer treatments. However, in the second season (Table 3) Super Alnawaya (25 kg/tree) increased fruit pulp (%) significantly over that of the Super Alnawaya (50 kg/tree). Fruit firmness was reduced by all treatments in comparison with the control treatment in the first season (Table 2) with a significant reduction by Alnawaya (25 kg/tree) and mineral fertilizer when compared with the control. In the second season (Table 3), Super Alnawaya (25 kg/tree) reduced fruit firmness by about 22% significantly in comparison with Super Alnawaya (50 kg/tree) and mineral fertilizer treatments. High doses of Super Alnawaya reduced fruit soluble solids content (SSC) significantly in the first season, when compared with Alnawaya (25 kg/tree) and the control treatments. On the other hand, no differences were noticed between different treatments in fruit SSC in the second season (Table 3).

Table 3. *Effect of mineral and bio-fertilizers on yield, fruit weight and quality of "Dabsha" mango (second season; 2011/2012).*

Treatments	Yield (Kg)	Fruit weight (gm)	Pulp (%)	Fruit Firmness (N)	[1]SSC (%)	Acidity (%)
Alnawaya (25Kg)	63.5	442.84	72.34	12.98	17.49	0.52
Alnawaya (50Kg)	68.75	395.88	71.02	13.1	17.3	0.62
[2] SA (25Kg)	76.76	465.5	73.58	11.88	17.36	0.62
SA (50Kg)	67.58	387.7	69.04	15.38	17.63	0.54
[3] Mineral fertilizer	84.64	388.5	72.74	15.34	17.93	0.55
Control	40.81	436.15	71.67	14.46	17.7	0.81
LSD (0.05)	34.96	97.57	3.43	3.04	1.47	0.24

[1]Soluble solids content
[2]SA = Super Alnawaya
[3]1500g N + 750g P + 1500g K/tree/year

In addition, the different treatments had no significant effect on fruit acidity in the first season while fruit acidity was lower in the second season as affected by the different treatments in comparison with that of the control.

In both seasons (Table 4), leaves mineral contents did not change radically by the treatments. Nitrogen leaves content increased by Alnawaya (50 kg/tree) and Super Alnawaya (50 kg/tree) in comparison with the rest of the treatments. No significant differences were recorded in phosphorus and potassium leaves content as a result of the different treatments.

Table 4. *Effect of mineral and bio-fertilizers on leaves mineral contents of "Dabsha" mango.*

Treatments	2010/2011 g $100g^{-1}$			2011/2012 g $100g^{-1}$		
	N	P	K	N	P	K
Alnawaya (25Kg)	1.53	0.18	0.74	1.33	0.10	0.69
Alnawaya (50Kg)	1.7	0.18	0.71	1.44	0.13	0.82
Super Alnawaya (25Kg)	1.63	0.13	0.73	1.39	0.11	0.77
Super Alnawaya (50Kg)	1.85	0.18	0.83	1.48	0.12	0.73
[1] Mineral fertilizer	1.58	0.15	0.80	1.21	0.10	0.67
Control	1.58	0.18	0.68	1.15	0.10	0.70
LSD (0.05)	0.21	0.08	0.21	0.21	0.04	0.21

[1]1500g N + 750g P + 1500g K/tree/year

4. Discussion

Mango tree yield and fruit weight were increased by Alnawaya and Super Alnawaya fertilizers over that of the control. In agreement of our finding, Hassan et al. (2013) reported that biological fertilizers increased fruit weight and pulp content. In addition, the data reported herein agreed with the finding that the addition of compost for two years increased fruit number by average of 17 and 24% in comparison with the same treatments without compost (Santos, 2007). Besides, our data were in harmony with that because pulp (%) of the fruits was increased by bio-fertilizers. This data can be also correlated with Abd El-Migeed et al. (2007) who found that bio-fertilizers increased juice contents of oranges. The reduction in fruit acidity by the bio-fertilizers, especially in the second season, revealed that the treatments might hasten fruit ripening. However, SSC was not affected significantly by the treatments and this was in harmony with Moustafa (2002) who stated that organic fertilizers had no significant effect on SSC of orange fruits. In contrary, Hassan et al. (2013) stated that vermin-compost fertilizer gave the highest SSC and the lowest acidity of mango fruit. Also, Sabbah, et al. (1997) mentioned that the organic fertilizers had no effect on orange fruits SSC and acidity. The contradiction between these finding and our data, in relation to the SSC and acidity, might be due to the differences of organic fertilizers types, the doses that were used, the location and soil types and the variety of fruit tree that was fertilized.

The data reported herein revealed that leaves mineral contents did not change radically by the treatments with an increment in N leaves content by Anawaya (50 Kg/tree) and Super Alnawaya (50 Kg/tree) compared with the rest of the treatments. Hassan et al. (2013) stated that the green manure, farm manure and vermin-compost fertilizers improved the available nutrients in the soil of mango orchard. Green manure increased N uptake by mango fruits. In addition, Atawiea et Al. (2007) reported that bio-fertilizers increased macro and micro elements in mango leaves.

5. Conclusion

Yield was increased by 88% and 66% by Super Alnawaya (25kg/tree) and Super Alnawaya (50 Kg/tree), respectively, in the second season and more than that in the first year. Besides, no significant differences were noticed in yield, average fruit weight or fruit quality between Super Alnawaya (25kg/tree) and mineral fertilization. Therefore, Super Alnawaya (25kg/tree) fertilizer is recommended to be used on 20 year-old "Dabsha" mango trees instead of Alnawaya, Super Alnawaya (50 Kg/tree) or mineral fertilizers. This bio-fertilizer could help, in addition of supporting the plants with the minerals they need, in improving the coarse soil condition and provide better aggregation and structure under the UAE environment.

Acknowledgement

We would like to thank the Bio Fertilizer Factory, UAE, for supporting this research by supplying the fertilizers needed.

References

[1] Xiuchong, Z., Guojian, L., Jianwu, Y., Shaoying, A., Lixian, Y. Balanced fertilization on mango in Southern China. Better Crop International, 15 (2): 16-20 (2001).

[2] Rahayu, M., Hidayah, B., Mujiono, H., Thistleton, B., Qureshi, S., Baker, I. Effect of pruning and fertilizing on production and quality of mango cultivar Gedong Gineu in West Nusa Tenggara province, Indonesia. Third International Conf. on Chemical, Biological and Environment Sci. Kuala Lumpur (Malaysia), (2013).

[3] Food and Agriculture Organization (FAO). World Agric. Infor. Center Database. http://www.fao.org/waicent/portal/statistics_en.asp. (2003).

[4] Chia, C. L., Hamilton, R. A., Evans, D. O. Mango commodity fact sheet MAN-3(A). Hawaii Coop. Ext. Ser., Univ. of Hawaii Press. 4 *pp*. (1988).

[5] Wanitprapha, K., Yokoyama, K. M., Nakamoto, S. T., Chia, C. L. Mango, Economic Fact Sheet No. 16. Dept. of Agric. And Resource. Econ., Univ. of Hawaii Press. 4*pp*. (1991).

[6] Cran, J. H., Campbell, C. W. The mango. IFAS Fact Sheet HS-2. Florida Coop. Ext. Serv., IFAS, Univ. of Florida. 4*pp*. (1994).

[7] Santos, B. M. Effect of adding compost to fertilization programs on 'Keitt' mango. J. of Agron. Asian Network for Sci. Infor., ISSN 1812-5379 (2007).

[8] Schumann, A. W., Faresm, A., Alva, A. K., Paramasivam, S. Response of Hamlin orange to fertilizer source, rate and irrigated area. Proc. Fla. State Hort. Soc. 116: 372-381 (2003).

[9] Shamseldin, A., El-Sheikh, M. H., Hassan, H. S. A., Kabeil, S. S. Microbial bio-fertilization approaches to improve yield and quality of Washington Navel orange and reducing the survival of nematode in the soil. J. Amer. Sci. 6 (12): 264-271 (2010).

[10] Dubey, A. K., Yadav, D. S. Response of Khasi mandarin to organic versus inorganic fertilization. Indian J. Agric. Res., 37 (3): 214-218 (2003).

[11] Moyin-Jesu, E. I., Adeofun, C. O. Comparative evaluation of different organic fertilizer on the soil fertility, leaf mineral composition and growth performance of mango seedlings. Emir. J. Food Agric. 20 (1): 18-30 (2008).

[12] Subba-Rao, N. S. Bio-fertilizers in Agriculture. Oxford IBH, Company New Delhi, *pp*: 1-786 (1984).

[13] Subba-Rao, N. S., Venkateraman, G. S., Kannaiyan, S. Biological nitrogen fixation Indian Council Agric. Res. New Delhi, *pp*: 112, (1993).

[14] Mansour, A. E. M., Shaaban, E. A. Effect of different sources of mineral nitrogen applied with organic and Bio-fertilizers on fruiting of Washington Navel Orange trees. J. Applied Sci. Res. 3 (8): 764-769 (2007).

[15] Farag, S. G. Minimizing mineral fertilizers in grapevine farms to reduce the chemical residuals in grapes. M.Sc. thesis, Institute of Environmental Studies and Research, Ain Shams Univ., Egypt (2006).

[16] El-Shiekh, A. F. and Burshaid, R. K. Quality evaluation of some local and imported mango cultivars grown in the UAE. Acta Hort. 875: 365-375 (2010).

[17] Drake, S. R., Proebsting, E. L., Mahan, M. O. and Thompson, J. B. Influence of trickle and sprinkle irrigation on "Golden Delicious" apple quality. J. Amer. Soc. Hort. Sci. 106: 255-258 (1981).

[18] AOAC. Official Methods of Analysis of AOAC International. 18th ed., 4th revision, (1998).

[19] Jones, W. W., Embleton, T. W. Leaf analysis-nitrogen control program for oranges. Calif. Citrogr., 45: 349-353 (C. F. Hort. Abst. 31: 3128), (1960).

[20] Hassan, M. A., Manna, M., Dutta, P., Bhattacharaya, K., Manadal, S., Banerjee, H., Ray, S. K. and Jha, S. Integrated nutrient management in improving fruit quality of mango 'Himsagar'. Acta Hort. 992: 167-172 (2013).

[21] Abd El-Migeed, M. M. M., Saleh, M. M. S., Mostafa, E. A. M. The beneficial effect of minimizing mineral nitrogen fertilization on Washington Navel orange trees by using organic and bio fertilizers. World J. Agric. Sci. 3 (1): 80-85 (2007).

[22] Moustafa, M. H. Studies on fertilization of Washington Navel orange trees. Ph. D. thesis, Fac. Of Agric., Moshtohor, Zagazig Univ., Benha, Egypt (2002).

[23] Sabbah, S. M., Bacha, M. A., El-Hamady, M. A. Effect of source and rate of nitrogen fertilization on yield, fruit quality and leaf mineral composition of Valencia orange trees grown in Riyadh, Saudi Arabia. J. King Saud Univ. Agric. Sci. 9 (1): 141-152 (1997).

[24] Atawiea, A. A., Bakry, K. A., El-Desouky, M. and El-Deen, Z. Physiological studies on fertilization of mango trees grown in Sinai. 1-Vegetative growth and nutritional status. Arab Conference of Soil and Water Management for Sustainable Agric. Development. 389-400 (2007).