Improving Mandarin Productivity and Quality by Using Mineral and Bio-Fertilization

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ABSTRACT

The present study was conducted during the two growing seasons 2009 and 2010 in Agwa farm, in Deby Rasheed , El Behera governorate to investigate the effect of using two sources of nitrogen and phosphorous; the first is the mineral fertilizers ammonium nitrate and calcium supper phosphate, and the second is the bio-fertilizers Nitrobin and Phosohorin, applied either alone or in combinations to different mandarin trees cultivars; Balady, Clementine and Chinese (Emperor). on the tree growth, leaf mineral contents and fruit quality. Obtained results indicated that, the Balady fruits had the highest leaf potassium and acidity content and higher leaf nitrogen as compared with Clementine, Furthermore. Clementine had the highest total soluble solids content. Meanwhile, the highest vitamin C content occurred in the Chinese variety. Additionally, leaf phosphorous, potassium, as well as fruit acidity contents in the three mandarin varieties increased only by applying 500 g mineral P plus 100 g Phosphorin..In addition, a significant increase in fruit total soluble solids was obtained by applying 300g Nitrobin. Furthermore, the treatment; 500 g mineral P plus 100 g Phosphorin and 250g mineral P + 200g Phosphorin increased fruit diameter . 750 mineral N plus 200g Nitrobin increased fruit length .Moreover, 750mineral N plus 200g Nitrobin and 300g Nitrobin showed an increase in leaf nitrogen as compared with 1500 g mineral N plus 100g Nitrobin in the first season.

Key words: Mandarin -bio-fertilizers- mineral composition- fruit quality.

INTRODUCTION

Citrus trees have an outstanding economical importance among fruit crops in Egypt. The total production of citrus fruit amounts to 2770000 tons representing 38..2 % of the total production of fruit trees in Egypt. Mandarin occupies the second planted citrus species after orange with 27.2 % of citrus cultivated area and 21.7 % of total citrus production (The Central of Horticulture Management 2002). Recently, the use and beneficial influence of bio-fertilizers is reported for various fruit species. Biofertilizers is known to increase the availability of many nutrients in the soil by improving their uptake and utilization (Abd – Elmoniem and Radwan, 2003). They increase and enhance the uptake of phosphorous and nitrogen by affecting the soil pH, phosphorus solubility and nitrogen fixation (Frankenberger and Arshed, 1995). Biofertilizers containing the Azotobacter produces many growth regulators such as IAA and GA which positively influence plant growth (Sharma and Kumar, 2008). Accordingly, the present investigation is carried out to study the effect of applying two different kind of fertilization; mineral and biofertilzers on growth, leaf mineral composition and fruit quality of three mandarin varieties.

MATERIALS AND METHODS

The present study was carried out during 2009 and 2010 seasons on 15 year old mandarin trees (*Citrus reticulata*, Blanco). Three mandarin cultivars, Balady, Clementine and Chinese (Emperor). budded on sour orange rootstock (*Citrus aurantium*, L.) were grown at Agwa farm in Deby Rasheed, El Behera governorate were used for this study. The soil was clay with pH of 7.89 and the soil analysis is presented in Table (1). It contained 0.15% available N, 1.04 mol/g available K, 23.2 mg/g available P and 2.37 % organic matter. Trees were selected as uniform as possible and received different mineral and bio- fertilizer applications.

Table1: Soil analysis of the experimental orchard.

Soil Texture		Soil depth(cm)	EC mmhos/cm	pH	Cations (meq/L)				Anions (meq/L)		
					K^+	Mg^{++}	Ca^{++}	Na^+	HCO_3^-	Cl^-	SO_4^-
Sand	37.9	0-30	1.54	7.89	o.308	3.5	6.1	5.5	5.13	6.33	3.79
Silt	19.2	30-60	1.36	7.89	0.509	4.1	3.1	4.88	2.9	6.7	4.8
Clay	42.9	60-90	1.23	7.57	0.576	7.4	3.5	6.1	3.7	9.54	5.24

The mineral fertilizers were ammonium nitrate {(33.5%N), mineral N} and calcium super phosphate{ (15.5%P_2O_5), mineral P}. The bio – fertilizers were Nitrobin (N-fixing bacteria) and Phosphoren (P-dissolved bacteria) produced by General Organization for Agriculture Equalization Found (GOAEF), Ministry of Agriculture, Egypt. Ammonium nitrate fertilizer was divided into two equal doses applied in March and May of both seasons. Calcium super phosphate was applied once in December of both seasons. The full dose of mineral N+P fertilizer (100%) was 3Kg ammonium nitrate + 1Kg calcium super phosphate per tree. Biofertilizers were applied once in May of both seasons and trees were subjected to the following treatments:

1- Control (3 Kg ammonium nitrate + 1Kg calcium super phosphate).
2- 1.5 kg ammonium nitrate + 100g Nitrobin.
3- 750 g ammonium nitrate + 200gm Nnitrobin.
4- 300 g Nitrobin.
5- 500 g calcium super phosphate + 100g Phosphorin
6- 250 g calcium super phosphate + 200g Phosphorin.
7- 300g Phosphorin.

Treatments were arranged in a randomized complete block design with three replications for each treatment and five trees for each replicate (7 treatments x3 replicates x 5 trees= 105 trees) for each variety. Mineral fertilizers were broadcasted on the soil surface and trees were irrigated after application. In addition, a sample of 8 leaves was taken in September from the middle part of non-fruiting spring shoots of each replicate in both seasons in order to determine leaf nutrients content. Leaf samples were washed with tap and distilled water, weighed and oven dried at 65-70°C to a constant weighed. The dried leaf were ground and digested with sulphuric acid and hydrogen peroxide as mentioned by Evenhius and Dewaard (1980). Suitable aliquots were taken for the determination of nitrogen and phosphorous colorimetrically according to Evenhuis (1976) and Murphy and Riley (1962). Potassium was determined by a flame photometer. Furthermore, a sample of five fruits was randomly taken from each replicate at harvest time of both seasons (February) in order to determine fruit physical and chemical quality characteristics; average fruit weight (g), fruit length and diameter (cm) were recorded. The percentage of fruit total soluble solids (TSS) was determined using a hand refractometer. The percentage of juice acidity as citric acid and vitamin C content as mg ascorbic acid/100 ml juice were determined according to A.O.A.C. (1995). Finally, all data obtained were statistically analyzed (two ways analysis) according to Snedecor and Cochran (1980) using SAS 1989.

RESULTS AND DISCUSSION

Leaf mineral content

With regard to the mandarin cultivars the data presented in Tables (2&3) showed that Balady mandarin had significantly higher leaf nitrogen content than Clementine in both seasons. In addition, data of the second season showed that Balady mandarin had significantly higher leaf potassium content than Clementine and Chinese (Emperor) cultivars. However, the three cultivars did not significantly differ among each other in their leaf phosphorous content .

As for the different fertilization treatments, obtained data in Tables (2&3) indicated that both treatments; 750 g mineral N +200g Nitrobin, and 300 g Nitrobin caused a significant increase in leaf nitrogen content in the first seasons as compared with 1500 g mineral N+100g Nitrobin. Furthermore, 1500 g mineral N +100g Nitrobin and 500 g mineral P+100g Phosphorin treatments significantly increased leaf phosphorous in comparison with the control and 250g mineral P+200g Phosphorin. treatment in the first season and all other treatments except 300g Phosphorin treatment In the second season. A significant increase in leaf potassium content was obtained by all treatments in the first season and 500 g mineral P+ 100g Phosphorin and 300g Phosphorin treatments in the second one in comparison with the control. These results were in harmony with those obtained by Solaiman et al (2003) working on "Balady" orange, they pointed that inoculation treatment had always greater nutrient element content at the same level of mineral fertilization, Usha et al (2003) working on mandarin, who concluded that Azotobacter application was beneficial for Kinnow trees through the release of higher concentrations of Malic, Citric, Furmaric and Shikimic acids that improve the availability of soil nutrients, Mohamed (2005) working on different citrus rootstocks, Sharawy (2005) working on Balady lime, Abd EL-Migeed et al (2007) working on Washington Navel orange, Ali et al (2007) working on Valencia orange, Wassel et al (2007) working Balady mandarin, Shaban and Mohsen (2009) on citrus rootstocks and El-Sisy et al (2011) working on guava. They all reported that the combined application of bio and mineral fertilizers increased leaf mineral composition. Also bio-fertilizer application gave higher leaf mineral composition than fertilization completely via mineral sources. Furthermore, Frankenberger and Arshed,1995, Abd –Elmoniem and Radwan, 2003. reported that, micro-organisms in bio-fertilizers maximize the availability of nutrients in the soil and improve their uptake and utilization.

Fruit Quality

With regard to the mandarin cultivars, the data presented in Tables (3, 4 & 5) showed that fruit total soluble solids of Clementine mandarin are

Table 2: The effect of bio and mineral fertilizers on the leaf nitrogen and phosphorous content.

Treatments	Leaf nitrogen (%)							Means	Leaf phosphorous (%)							Means
	2009			Means	2010				2009			Means	2010			
	Balady	Clementine	Chinese		Balady	Clementine	Chinese		Balady	Clementine	Chinese		Balady	Clementine	Chinese	
Control (3 Kg mineral N + 1Kg mineral P)	2.49	1.93	1.92	2.11	2.17	2.05	**1.99**	**2.07**	0.179	0.156	0.141	0.164	0.253	0.235	0.127	0.218
1.5kg mineral N +100 gNitrobin.	2.01	1.71	1.99	1.99	2.44	1.99	**2.16**	**2.2**	0.239	0.261	0.309	0.269	0.234	0.286	0.281	0.267
750 g mineral N +200g Nitrobin	2.49	2.41	2.47	2.46	2.42	2.47	2.13	2.34	0.231	0.293	0.199	0.230	0.186	0.190	0.19	0.187
300gNitrobin.	2.96	2.69	1.95	2.54	2.39	2.28	2.22	2.3	0.321	0.225	0.21	0.252	0.203	0.229	0.157	0.196
500 g mineral P + 100g Phosphorin.	2.79	1.97	2.36	2.37	2.74	1.97	2.27	2.34	0.167	0.237	0.363	0.256	0.241	0.229	0.318	0.263
250g mineral P+200g Phosphorin.	2.34	1.85	2.29	2.16	2.40	1.87	2.19	2.16	0.158	0.216	0.175	0.183	0.215	0.213	0.159	0.196
300 g Phosphorin.	2.37	1.83	2.45	2.22	2.42	1.88	2.23	2.17	0.234	0.288	0.207	0.243	0.254	0.233	0.185	0.224
Mean	2.49	2.06	2.21		2.42	2.07	2.17		0.218	0.229	0.229		0.227	0.231	0.203	
0.525		0.324		0.494		0.344		0.525		0.034		0.051		0.031		0.048.

Table 3: The effect of bio and mineral fertilizers on leaf potassium and fruit total soluble solid content.

Treatments	Leaf potassium (%)								Fruit total soluble solids (%)							
	2009			Means	2010			Means	2009				2010			Means
	Balady	Clementine	Chinese		Balady	Clementine	Chinese		Balady	Clementine	Chinese	Means	Balady	Clementine	Chinese	
Control (3 Kg mineral N + 1Kg mineral P)	1.09	1.06	1.29	1.15	1.3	1.32	1.3	1.31	9.93	10.33	9.00	9.75	9.23	10.92	11.37	10.51
1.5kg mineral N +100 gNitrobin.	2.33	2.17	1.29	1.93	1.48	1.81	1.17	1.49	10	10.47	10.17	10.21	12.2	12.39	11.51	12.04
750 g mineral N +200gm Nitrobin	1.83	1.36	1.86	1.68	1.87	1.38	1.47	1.57	11.27	11.17	10.7	11.04	12.46	11.47	12.35	12.09
300gm Nitrobin.	1.44	1.93	1.51	1.63	2.01	1.38	1.38	1.59	11.13	11.6	9.97	10.9	12.32	12.17	12.79	12.43
500 g mineral P + 100g Phosphorin.	1.97	2.35	1.92	2.08	2.84	2.03	1.75	2.21	10.5	11.16	9.33	10.33	10.2	11.25	12.31	11.25
250g mineral P+200g Phosphorin.	1.62	1.44	1.64	1.57	1.66	1.38	1.58	1.54	10.33	10.93	10	10.42	11.37	10.38	12.03	11.26
300gPhosphorin.	2.14	2.05	1.37	1.85	2.95	2.22	1.34	2.17	9.43	11.5	9.57	10.17	11.04	11.59	12.32	11.65
Mean	1.77	1.76	1.56		2.02	1.65	1.43		10.37	11.02	9.82		11.26	11.46	12.09	
L.S.D 0.05		0.227		0.347		0.3291		0.503		.535		0.817		0.497		0.754

Table 4: The effect of bio and mineral fertilizers on fruit acidity and vitamin C content.

Treatments	Acidity (%)								Vitamin C mg ascorbic acid /100ml juice							Means
	2009			Means	2010			Means	2009			Means	2010			
	Balady	Clementine	Chinese		Balady	Clementine	Chinese		Balady	Clementine	Chinese		Balady	Clementine	Chinese	
Control (3 Kg mineral N + 1Kg mineral P)	1.23	1.39	0.561	1.06	1.23	1.18	0.617	1.01	33.3	31.87	38.94	34.7	36.7	42.76	42.83	40.77
1.5kg mineral N +100 gNitrobin.	0.895	0.955	0.653	0.83	0.941	0.949	0.701	0.86	36.63	55.47	30.1	40.73	43.1	55.8	33.1	43.99
750 g mineral N +200g Nitrobin	1.39	0.837	0.712	0.98	0.855	0.835	0.784	0.82	36.33	52.76	41	43.37	49.97	58.03	54.97	54.32
300g m Nitrobin.	1.34	0.836	0.993	1.05	0.985	0.760	1.093	0.95	37.3	69.25	73.73	60.09	52.4	66.63	81.1	66.71
500 g mineral P + 100gPhosphorin.	1.32	1.18	1.62	1.37	0.928	1.143	1.45	1.17	47.17	54.83	75.46	59.15	52.2	52.1	82.3	62.19
250g mineral P+200gPhosphorin.	1.43	0.983	0972	1.13	1.57	0.923	0.748	1.08	55.37	38.3	67.1	53.59	47.5	49.86	61.89	53.09
300g Phosphorin.	1.39	1.36	0.605	1.12	1.53	1.33	0.672	1.18	41.48	37.63	43.03	40.72	48.93	49.33	47.33	48.53
Mean	1.28	1.08	0.874		1.15	1.02	0.867		41.08	48.3	52.76		47.25	53.50	57.64	
L.S.D 0.05		0.146		0.223		0.140		0.214		5.56		8.49		6.69		10.23

Table 5: The effect of bio and mineral fertilizers on fruit length and fruit diameter.

Treatments	Fruit length (cm)								Fruit diameter (cm)							Means
	2009			Means	2010			Means	2009			Means	2010			
	Balady	Clementine	Chinese		Balady	Clementine	Chinese		Balady	Clementine	Chinese		Balady	Clementine	Chinese	
Control (3 Kg mineral N + 1Kg mineral P)	4.9	5.3	5.34	5.18	5.26	4.83	5.83	5.31	6.03	5.7	7.05	6.10	6.33	5.2	7.43	6.32
1.5kg mineral N +100 g Nitrobin.	5.2	6.66	4.04	5.30	5.27	6.08	4.4	5.25	5.62	6	5.6	5.74	5.73	6	6.3	6.01
750 g mineral N +200g Nitrobin	4.67	7.17	5.31	5.71	5.33	6.4	5.8	5.87	5.83	6	5.63	5.82	6.93	5.6	5.77	6.1
300gm Nitrobin.	4.75	6.57	4.79	5.37	4.93	4.5	5.3	4.91	5.64	6.64	5.18	5.82	5.5	5.37	5.7	5.52
500 g mineral P + 100gPhosphorin.	4.9	5.76	5.12	5.26	5.5	6.15	5.63	5.76	5.87	5.9	6.03	5.93	6.4	6.8	6.73	5.54
250g mineral P+200g Phosphorin.	5.36	5.48	5.27	5.37	5.9	5.33	5.8	5.68	6	6.02	6.36	6.13	6.6	6.47	6.9	6.66
300g Phosphorin.	4.96	4.31	4.94	4.74	6.05	5.14	5.3	5.49	6.04	5.34	5.06	5.48	6.67	5.87	5. 57	6.03
Mean	4.96	5.89	4.97		5.46	5.50	5.44		5.86	5.94	5.85		6.30	5.90	6.34	
L.S.D 0.05		0.423		0.646		0.489		0747		0.532		0.813		0.448		0.684

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significantly higher than Balady and Chinese mandarin in the first season. Whereas, Chinese (Emperor) had significantly higher total soluble solids than Balady and Clementine mandarin in the second one. However, the higher fruit acidity content was obtained in the Balady mandarin and " Clementine "cultivars in the first seasons when compared with Chinese (Emperor). Furthermore, in the second seasons Clementine had significantly higher fruit acidity when compared with Chinese. Additionally, Chinese (Emperor)mandarin had significantly higher vitamin C content than the Balady mandarin variety in both season. In addition ,the data of the first season presented in Table (5) showed that the Clementine cultivars obtained the highest fruit length. However, all varieties indicated no significance differences among each other in their fruit diameter.

As for the effect of the different fertilization treatments, the data of both seasons presented in tables (3 & 4) indicated that 300 gm Nitrobin and 750 g mineral N +200 gm Nitrobin. significantly increased fruit total soluble solids as compared with the control in the first season and all treatments except 1.5kg mineral N +100 g Nitrobin. and 300 gm Phosphorin in the second season. Vitamin C content was significantly higher by adding 300 gm Nitrobin as compared with the control, 1.5kg mineral N +100 g Nitrobin.,750 g mineral N +200 gm Nitrobin and 300 gm Phosphorin in both seasons. Moreover, fruit acidity increased significantly by 500 g mineral P+ 100g Phosphorin treatment than all treatments in the first season and than 1.5kg mineral N +100 g Nitrobin., 750 g mineral N +200gm Nitrobin and 300gm Nitrobin in the second season. 1.5kg mineral N +100 g Nitrobin had significantly the lowest fruit acidity as compared with the control, 250mineral P+200g Phosphorin and 300g Phosphorin in the first season. The obtained results were in agreement with those reported by Mostafa (2002) on Washington navel orange and, Salama (2002) on Balady mandarin. Also, Akl et al (1997) on grapevines who found that Phosphorin and active dry yeast caused highly increase in berry set ,Mansour (1998) reported that bio-fertilizer were very effective in improving yield of Anna apple, Abdle –Hamid, 2002.who reported bio-fertilization and bio-stimulant gave the highest fruit volume and weight for olive and Osman (2003) working on Zaghloul date revealed that bio-fertilizer treatment was the best one regarding yield and fruit characteristics for Zaghlool. cv. under Alexandria conditions.

CONCLUSION

Balady trees had the highest leaf potassium and fruit acidity content and higher leaf nitrogen than the Clementine mandarin. Whereas, the Clementine had the highest total soluble solids content. In the meanwhile, the highest Vitamin C content occurred in the Chinese mandarin. The treatments; 500 g mineral P + 100 g Phosphorin and 300g Nitrobin resulted in the best effect on improving most of the fruit chemical and physical quality characteristics. In general bio-fertilizer combination with nonorganic fertilizer increased N and P content and improve fruit quality.

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الملخص العربى

تاثير التسميد الحيوى على اشجار اليوسفى

هالة محمد الخياط، محمد امام عبد الرحيم

مركز البحوث الزراعية- معهد البساتين

اجريت الدراسة الحالية خلال موسمى الدراسة ٢٠٠٩ و٢٠١٠ بمزرعة بساتين عجوة بمركز رشيد محافظة البحيرة لدراسة تاثير معدلات التسميد المعدنى (نترات امونيوم وسوبر فوسفات الكالسيوم) والتسميد الحيوى (نيتروبين وفوسفورين) مختلطة على المحتوى المعدنى وصفات جودة الثمار لاشجار اليوسفى صنف البلدى والكلمنتين والصينى(صنف الامبراطور) واظهرت النتائج الاتى:

١. احتوى اليوسفى البلدى على اعلى نسبة من البوتاسيوم والنيتروجين ايضا احتوى على اعلى نسبة حموضة٠
٢. احتوى اليوسفى صنف الكلمنتين على اعلى نسبة من المواد الصلبة الزائبة اما اليوسفى الصينى صنف (الامبراطور) احتوى على اعلى نسبة فيتامين ج٠
٣. ادت المعاملة ب ٣٠٠جرام نيتروبين لزيادة نسبة فيتامين ج فى الموسم الثانى والمواد الصلبة الزائبة فى كلا الموسمين٠
٤. ايضا ادت المعاملة ٥٠٠ سوبر فوسفات الكالسيوم و١٠٠جرام فوسفورين او٢٥٠سوبر فوسفات الكالسيوم و٢٠٠جرام فوسفورين الى زيادة قطر الثمار٠
٥. ايضاادت المعاملة ب٧٥٠ نترات امونيوم +٢٠٠جرام نيتروبين الى زيادة طول الثمار٠
٦. ادت كل المعاملات ب٧٥٠ نترات امونيوم +٢٠٠جرام نيتروبين والمعاملة ب ٣٠٠جرام نيتروبين لزيادة محتوى النيتروجين بالمقارنة ب١٥٠٠ نترات امونيوم +١٠٠جرام نيتروبين فى الموسم الاول٠
٧. ايضا ادت المعاملة ٥٠٠ سوبر فوسفات الكالسيوم و١٠٠جرام فوسفورين لزيادة الفوسفور والبوتاسيوم والحموضة بالمقارنة بالكنترول٠