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Evaluation of Four Exotic Mandarin Cultivars under Egyptian Agro-Climatic Conditions in Newly Reclaimed Land

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Abstract: This investigation was conducted for three successive seasons (2012, 2013 and 2014) at Horticultural Research Station, South El Tahrir, Beheira governorate, Egypt to evaluate the performance of four newly imported mandarin cultivars (*Citrus reticulata* Blanco) namely Nour, Fina, Fedele and Avana apireno all were grafted on Volkamer lemon (*Citrus volkameriana*). Maximum increment in canopy volume was observed in Nour followed by Avana apireno while the minimum canopy spread was observed in Fina in the three seasons of study, respectively. Nour trees had the largest leaf area and proved to be superior, whereas Avana apireno had the lowest values in this concern. For yield components Avana apireno trees showed the highest fruit yield followed by Nour cultivar while the other two varieties Fedele and Fina had the lowest values in this concern. Avana apireno mandarin had the highest number of seeds per fruit while Nour cultivar gave the lowest number of seeds per fruit. For Alternate bearing habit; 'Avana apireno' cultivar had a very low tendency of alternate bearing followed by Nour cultivar while 'Fedele' and 'Fina' cultivars had the tendency of being high biennial bearing. Minimum juice TSS percentage was observed in Avana apireno fruits while, Fedele fruits juice achieved the maximum values. Concerning fruit juice acidity, Avana apireno gained the highest values while the other varieties came in second rank without significant differences among them. The highest TSS/acid ratio in fruit juice was observed for Nour fruits followed by Fedele then Fina while Maximum Vitamin C content was recorded in Nour fruits.

Key words: Evaluation · *Citrus reticulata* Blanco · Nour · Fina · Fedele · Avana apireno · Alternate bearing · Canopy volume · TSS · Acidity

INTRODUCTION

Citrus is one of the most important commercially cultivated fruit crops in the world [2]. It has a wide distribution and large-scale production worldwide, hence considered one of the major fruit tress contributors to the world's economy. In Egypt, citrus ranks the first among fruit crops. Mandarin (*C. reticulata*) together with the grapefruit (*C. maxima*) and citron (*C. medica*) are the three-basic species of the subgenus Citrus. According to, Ministry of Agriculture and reclamation statistics [1] the recorded cultivated area was 533, 835 feddan produced about 4, 646, 579 tons. Where, the cultivated citrus area of mandarin reached 147, 562 feddan produced about 952, 371 tons.

For citrus exporters it is a necessitate to convene international market and consumers' requirements. Therefore, the evaluation of the performance of newly imported citrus varieties that can produce good fruit quality under the Egyptian condition that could help exporters to access to the new markets and to supply reasonable profit. Furthermore, introducing novel varieties can help in expanding the production, decrease the risk that might be occurred and increase the production seasons in to compete with other citrus producers.

Alternate bearing phenomenon exemplifies one of the production problems in mandarin orchards worldwide producing fruits with low commercial value [3-5]. The purpose of this study is to evaluate the performance of newly imported citrus varieties under the conditions of Beheira governorate at South El-Tahrir district, hence make that information available to growers in order to expand areas Citrus orchards with recommended cultivars.

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Table 1: The scientific names, parentages and origin of the mandarin cultivars in this study

Cultivar	Scientific name	Parentage	Origin
Avana apireno	*C. deliciosa* TAN.	a selection (bud sport) of Mediterranean	Italy
Nour	*Citrus reticulate*	a mutation of 'Cadoux'	Morocco
Fina	*C. clementina* HORT. ex. TAN.	The original Clementine cultivar	Imported from Algeria into Spain in 1925
Fedele	*C.clementina* HORT.ex.TAN.	Spontaneous mutation from C. reticulata commune	Italy

MATERIALS AND METHODS

This investigation was carried out during three successive seasons 2011/2012, 2012/2013 and 2013/2014 at Horticultural Research Station, South El-Tahrir, Beheira governorate to evaluate the performance of four mandarin (*Citrus reticulata* Blanco) cultivars Nour, Fina, Fedle and Avana aprino grafted on Volkamer lemon (*Citrus volkameriana*) (Table 1).

The grafted plants where imported from Italy by Horticulture Research Institute. Trees were nine years old planted at 5 X 5 meters apart. Trees received similar management practices as recommended by the Ministry of agriculture. The following measurements were recorded:

Vegetative Growth Characteristics: Tree canopy volume (m^3): At spring cycle, tree height (m) and tree diameter (m) were measured and tree canopy volume was calculated according to the equation: Tree canopy volume (m^3) = $0.528 \times H \times D^2$.

where H: is the canopy height, D: is the canopy diameter [6].

Leaf Area: Twenty mature leaves taken from four secondary branches around each tree; leaf area (cm^2) was measured by using a CI-203- Laser Area-meter made by CID, Inc., Vancouver, USA.

Yield Components: Yield data was estimated by counting the number of fruits per tree, the average fruit weight of 30 fruits was taken from each replicate then the yield per tree was calculated in kg.

At harvest time fifteen fruits from each tree were used to estimate number of mature seeds and segments per fruit for the studied cultivars

Alternate Bearing Index (I): Was calculated for the 3 years of the study according to the following equation:

$$I = \frac{1}{n-1}\left(\frac{a_2 - a_1}{a_2 + a_1} + \frac{a_3 - a_2}{a_3 - a_2} + \ldots\ldots\ldots\frac{a_n - a_{(n-1)}}{a_n - a_{(n-1)}}\right)$$

where n = number of years, a_1, a_2, …, $a_{(n-1)}$, a_n represent yields of corresponding years, When ABI = 0, there is no alternate bearing and when ABI = 1, alternate bearing is 100% [7].

Fruit Chemical Properties: Total soluble solids in fruit juice (TSS) percentage were determined using a hand refractometer

Total titratable acidity was expressed as citric acid percentage by titrating 10 ml juice with (0.1N) NaOH using phenolphthalein as indicator according to A.O.A.C. [8] and TSS/acid ratio was calculated.

Vitamin C (Ascorbic acid) of the fruit juice (mg/100g fresh weight) was calculated according to Ruck [9].

Statistical Analysis: The complete randomized blocks design was used for the experiment. The data statistical analysis carried out according to Snedecor and Cochran [10]. Averages were compared using L.S.D test at 5% level.

RESULTS AND DISCUSSION

Vegetative Growth Characteristics: Hostler, *et al*. [11] declared that there was a positive correlation between tree canopy and fruit yield. In this line, illustrated data (Table 2) revealed significant increments of canopy volume among the different cultivars.

Leaf area, is another important vegetative characteristic of citrus tree. Nour tress had average leaf areas of 15.23, 15.98, 15.81 cm^2 during the three studied seasons respectively and proved to be superior in this respect, whereas Avana apireno attained the least values (8.45, 8.66, 8.61cm^2) during the three studied seasons respectively.

Yield Components: Producing a profitable yield in terms of quantity and quality is crucial for fruit tree growers. The results of fruit weight beside fruit number are closely associated with the accumulated fruit yield. This is clearly shown in the case of fruit produced by Avana apireno trees which had the highest fruit yield compared with other cultivars. Nour came in the second rank in this respect while the other two varieties Fedele and Fina had the lowest values in this concern (Table 3).

Table 2: Tree canopy volume and leaf area of studied cultivars

	Tree canopy volume (m^3)			Leaf area (cm^2)		
Cultivar	2012	2013	2014	2012	2013	2014
Avana apireno	15.23	16.11	16.85	8.45	8.66	8.61
Fedele	7.58	7.98	9.01	10.21	10.15	10.49
Nour	16.78	17.25	18.69	15.23	15.98	15.81
Fina	6.45	7.25	7.85	10.28	10.25	10.43
L.S.D. at 0.05	1.32	1.41	1.57	1.34	1.21	1.32

Table 3: Fruit weight and yield of studied cultivars

	Fruit weight			Fruit number/tree			Yield/tree (kg)		
Cultivar	2012	2013	2014	2012	2013	2014	2012	2013	2014
Avana apireno	101.0	116.7	113.3	744.5	506.1	725.8	75.2	59.1	82.3
Fedele	162.7	78.9	140.4	331.2	195.7	363.4	53.9	15.4	51.0
Nour	107.5	104.9	126.4	618.8	298.2	577.8	66.5	31.3	73.0
Fina	119.5	94.1	105.4	429.3	161.4	453.3	51.3	15.2	47.8
L.S.D. at 0.05	11.23	9.87	12.11	35.14	26.31	44.36	5.11	4.12	6.22

Table 4: Number of seeds and aborted seeds of the studied mandarin cultivars in 2012, 2013 and 2014 seasons

	Number of Seeds/fruit			Aborted seeds/fruit		
Cultivar	2012	2013	2014	2012	2013	2014
Avana apireno	4.31	4.07	4.25	3.0	2.3	2.7
Fedele	1.52	1.73	1.36	4.6	5.6	5.0
Nour	0.62	0.79	0.73	0.0	0.0	0.0
Fina	2.74	2.53	2.91	0.0	0.0	0.0
L.S.D. at 0.05	0.51	0.44	0.36	0.35	0.41	0.33

Crop load is likely the trigger causing alternate bearing cycles of many citrus species and varieties [12]. These significant results were in line with those obtained by Nicotra [13] on Spinoso and Fedele cultivars. Furthermore, our results of high variations among the studied cultivars are in line with Sayed and Abdel-Aziz [14] and confirmed the published information from the originated area where those cultivars were introduced.

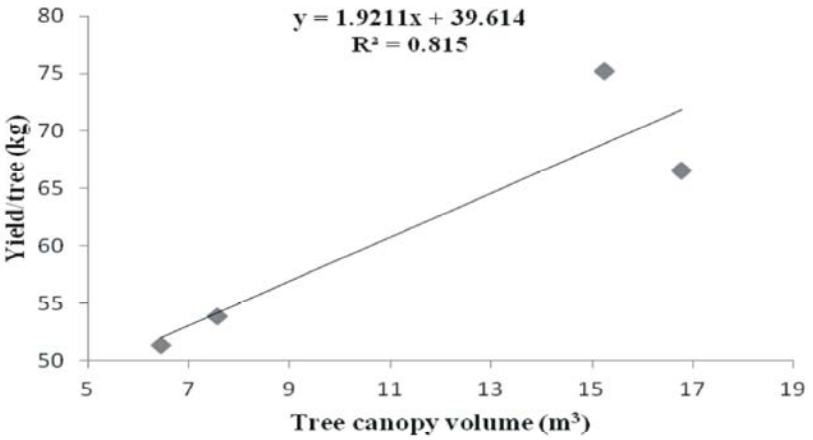
Hostler, *et al*. [11] declared that there was a positive correlation between tree canopy volume and fruit yield. In this line, illustrated Data (Figure, 1) confirmed the presence of a positive correlation between the tree canopy volume (m3) and yield (kg), where (r = 0.902785, 0.782607& 0.933777) for the studied cultivars in the three seasons respectively.

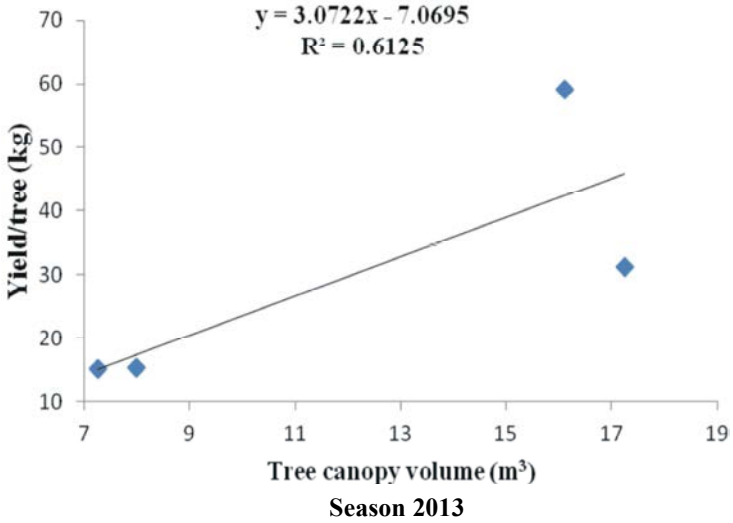
Number of Seeds per Fruit: Tabulated data (Table 4) indicated that studied cultivars showed highly significant variation in number of seeds per fruit during the three seasons of the study. However, significant differences were found in the second season only.

Avana apireno mandarin had the uppermost number of seeds per fruit in both seasons. While, Nour cultivar had the lowest seeds per fruit for second season. Concerning the Aborted seeds/fruit obtained results illustrated that Fedel cultivar show the highest number of aborted seeds/fruit while both Nour and Fina fruit contain no aborted seeds These significant results are in line with those obtained by Nicotra [13] on Spinoso and Fedele cultivars.

Alternate Bearing Index (I): Results in Fig. (2) revealed that cultivar ‘Avana apireno’ had a very low tendency to alternate bearing followed by Nour cultivar which must be considered pertaining to the commercial growing scale. There is a dissimilar situation for ‘Fedele’ and ‘Fina’ as; they tended to be very high biennial bearing, despite the very high commercial value. Cultural practice such as pruning as well as thinning of flower or fruitlet and the applications of plant growth regulators have been reported to regulate alternate bearing cycles in fruit trees [15, 16].

Yet, cultivar had the greatest impact on alternate bearing, hence attracted the attention of many research groups around the globe especially, in introducing the new mandarin cultivars [17].





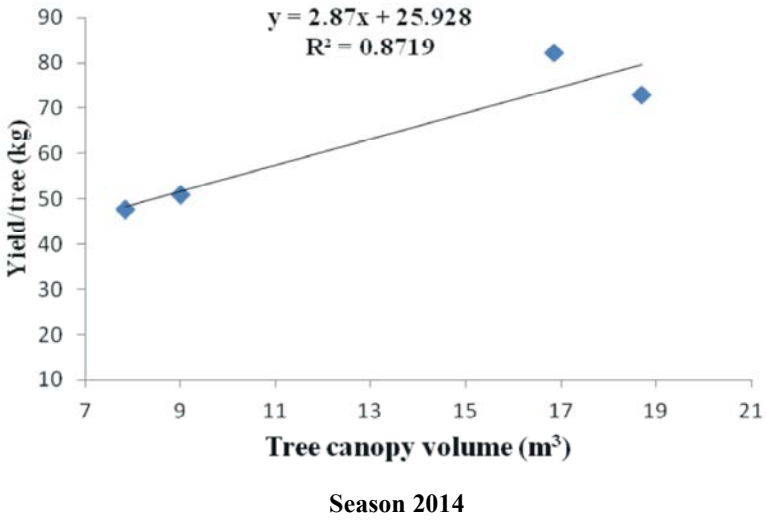


Fig. 1: The relationship between the tree canopy volume (m^3) and yield/tree (kg) for the four studied cultivars during three seasons

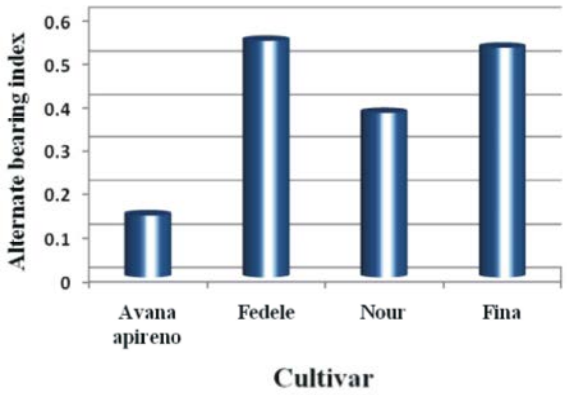


Fig. 2: Alternate bearing index (I) for the four studied cultivars

Table 5: Fruit chemical properties of four mandarin cultivars

	TSS %			Acidity %			TSS /Acid ratio			Vitamin C (mg/100ml)		
Cultivar	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
Fina	10.76	10.84	10.62	0.98	0.98	0.96	10.93	11.01	11.03	49.65	55.40	57.05
Avana apireno	8.40	9.31	9.09	1.04	1.06	1.02	8.09	8.82	8.87	31.91	32.08	36.84
Nour	10.89	10.89	10.96	0.88	0.89	0.88	12.40	12.27	12.44	54.44	52.88	62.45
Fedele	10.93	10.46	10.52	0.97	0.95	0.94	11.30	11.01	11.22	37.23	37.58	42.65
L.S.D. at 0.05	1.56	1.12	1.22	0.05	0.03	0.04	0.6	0.5	0.7	4.2	4.7	3.9

Fruit Chemical Characteristics: The essence and tastiness of citrus fruits is a function of compensation between levels of soluble solids, acids and the presence or absence of various aromatic or bitter juice constituents [18]. The TSS is known to increase as and when the fruit matures while total acidity remains constant. The decrease in total acidity was due to dilution effect as a result of increase in fruit size and increase in TSS content [19]. Minimum juice TSS percentage was observed in the fruits of Avana apireno (Table 5). While, the Fedele fruits juice achieved the maximum values in this concern with followed by Fina then Nour with lake of significant between them in both seasons of study.

Pertaining fruit juice acidity, the investigated varieties followed a dissimilar trend in converse way. As, Avana apireno gained the highest values while the other varieties came in second rank in this respect without significant differences among them.

TSS/acid ratio of citrus juices is an important factor in overall juice quality and in determining the time of harvest in several citrus producing countries. The marketability of citrus is determined by the ratio of TSS to total acidity [20]. Result in Table (5) revealed that the studied varieties exhibited a significant distinction on TSS/acid ratio of the juice fruits. The highest ratio in fruit juice induced by Nour followed by Fedele then Fina, whereas Avana apireno resulted in significantly the lowest values in this affair.

As shown in (Table 5) the results revealed that, maximum vitamin C content was recorded in Nour fruits followed by Fina and minimum ratio was observed in Fedele and Avana apireno.

The differences in chemical composition of fruit juices can be attributed to the genetic influence occurring among different cultivars, existence of diversity and physiological factors [21, 20].

CONCLUSION

Although, Avana apireno has meritorious characteristics as a vigorous growth and yielded the highest fruit number and weight as well as having a very low tendency to alternate bearing but inferior fruit quality i.e., seedy fruits with low TSS, high acidity and low TSS /acid ratio, which are not accepted in export and local market. While, Nour produced a nearly moderate seedless fruit yield with well blended chemical quality traits along with a restrained biennial bearing habit. On the other hand, the other two varieties Fina and Fedele had substandard estimation for nearly the most of studied parameters.

So, it could be concluded that Nour mandarin proved as a reliable cultivar under the prevailing agro-climatic conditions of South El Tahrir district, Egypt.

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