

AN ATTEMPT FOR PRODUCING BALADY LIME FRUITS ALLOVER THE YEAR BY FRUIT THINNING USING NAA

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Abstract: This study was established during 1999/2000 and 2000/2001 seasons as an attempt for inducing fruits of Balady lime fruits allover the year and improving fruit quality by fruit thinning with 0.0, 400, 600 and 800 ppm NAA once at the heavy crop stage (first of May). The tested trees received 1000 g N /tree (300 g /tree on mid January and 700 g /tree on the last week of August).

Thinning by NAA at 400-800 ppm was very effective in reducing seasonable yield expressed in weight and number of fruits per tree on periods from July to December and total seasonable yield as well as in increasing unseasonable yield on periods from January to June and total unseasonable yield compared to unthinning. Annual yield was also tended to reduce with thinning treatments. The effectiveness of NAA was associated with increasing its concentrations. Generally, fruit weight and dimensions were higher in

unseasonable yield than in seasonable one. Increasing NAA concentrations was accompanied with increasing fruit weight in seasonable yield and decreasing it in unseasonable one. A slight effect on fruit dimensions, Juice % and fruit peel thickness was recorded due to raising NAA from 600 to 800 ppm. A remarkable promotion on chemical fruit quality in terms of increasing the total soluble solids and ascorbic acid and in reducing the total acidity was detected due to raising NAA concentrations. Hardly any effect on such parameters was observed due to raising NAA concentrations from 600 to 800 ppm.

Spraying Balady lime trees once at (1st week of May) with 600 ppm NAA and supplying them with 1000 g N /tree (twice at 300 g N /tree in mid January and 700 g N /tree in the last week of August) was necessary for inducing yield during the whole year and improving fruit quality.

Introduction

In Egypt, citrus is the backbone of fruit culture, as far as its nutritive value acreage, production and exportation potentials are concerned. The Balady lime is highly favourable by the consumer in Egypt

and middle East, due to its high acidity and pleasant flavour. Egypt is the second highest producer of lime in the world. Lime ranks third after orange and mandarin in Egyptian citrus industry. According to the 2000 statistics inventory of

the Egyptian Ministry of Agriculture, the total acreage of citrus was 350000 representing about 37.1 % out of the total area occupied by fruit orchards. Total area of lime groves amounted to 36227 fed. producing around 421811 tons.

It is well known that Balady lime trees produce heavy crop during summer and autumn seasons followed by light and unsatisfactory yield in the remainder seasons (winter and spring seasons) of the year. A heavy crop links with excessively small sizes and yield has market value. Thus, net return to lime growers is usually greatly reduced (Wheaton, 1981 and Gallasch, 1988). One approach to solve this problem has been fruit thinning during the heavy crop stage (Cutuli, 1973 and Almaguer *et al.*, 1993). Inducing yield of lime fruits, all over the yield through the traditional method depends on preventing the irrigation water at specific stages caused a great weakness and damage to lime trees grown under sandy soil. Therefore, application of Naphthalene acetic acid (NAA) for fruit thinning is necessary instead of the traditional method for obtaining yield lime through all months of year. NAA has been proved to be very potent as a thinning agent for most citrus species. It is used to control crop load during the year by stimulating the naturally occurring fruit drop

especially during the periods of heavy crop (Josan and Sharma, 1990; Ortola *et al.*, 1991; Perez *et al.*, 1994; Hartey and Sullon, 1994; Salem *et al.*, 1995; Greenberg *et al.*, 2000; Ono *et al.* 2000 and Ibrahiem *et al.*, 2001). Controlling of yield in response to NAA caused a favourable promotion on fruit quality of citrus (Gallasch, 1988; El-Kassas *et al.*, 1994; Rabe, 1994 and Kanonich *et al.*, 2000).

This study was initiated as an attempt for inducing yield of Balady lime trees all over the year and improving fruit quality by using NAA as a potential chemical fruit thinner.

Material and Methods

This study was carried out during two successive seasons of 1999/2000 and 2000/2001 seasons on twenty-four of 22 years old seeded Balady lime trees (*Citrus aurantifolia* Swingle) situated in Derwa village, near Mallawy district, Minia Governorate.

The soil of the experimental orchard was sandy. Trees spacing is 5 x 6 meters. The depth of water table was more than two meters. All the investigated trees were subjected to the normal horticultural practices and were healthy and uniform in vigour as possible.

Naphthalene acetic acid was sprayed once on the first week of May, 1999 and 2000 at 0.0, 400, 600 and 800 ppm. Triton B, as a wetting

agent at 0.1 % was added to all the used spraying solutions. Spraying was carried out till runoff (10 L was sufficient for each tree). A completely randomized block design was used. The experiment involved four treatments, each replicated three times, two trees per each. Control trees were sprayed with Triton B solution at 0.1 %. The tested trees received N at 1000 g /tree at two unequal batches, 300 g N /tree at the middle of January (before Spring bloom) and again at 700 g N /tree at the last week of August (before Autumn bloom) in 1999 and 2000 seasons.

Seasonable yield was recorded in the periods from July to December expressed in weight of fruits (kg) and number of fruits per tree. In addition, unseasonable yield in the periods from January to June was also recorded at the same manner. Afterwards, total seasonable and unseasonable yields as well as annual yield were registered. Seasonal changes in the fruit weight of seasonable and unseasonable yields were estimated.

At harvesting time (Last week of July for seasonable yield and last week of February for unseasonable yield in both seasons), random samples of twenty fruits were picked from each replicate. Fruits were used for determination of fruit weight (g) and dimensions (Width and height, cm), fruit peel thickness (cm), Juice %, total soluble solids

%, total acidity % (expressed as g citric acid /100 ml juice) and vitamin C content (as mg ascorbic acid /100 ml juice). (According to A. O. A. C, 1985)

All the obtained data were tabulated and subjected to the proper statistical analyses according to Steel and Torric (1980) using new L.S.D for comparing between various treatment means

Results and Discussion

1- Effect of fruit thinning with NAA on seasonable, unseasonable and annual yields:-

Data in Tables (1, 2, 3 & 4) clearly show that spraying NAA at 400-800 ppm significantly reduced seasonable and annual yield, expressed in weight and number of fruits per tree compared to unthinning. The reduction was correlated with increasing NAA concentrations.

However unseasonable yield expressed in weight and number of fruits per tree was positively affected by fruit thinning with NAA at the same previous concentrations, since increasing NAA concentrations was followed by gradual increase on unseasonable yield. Raising NAA concentrations from 600 to 800 ppm caused insignificant effect on seasonable, unseasonable and annual yield of Balady lime trees. Therefore, application of 600 ppm NAA succeeded in producing

Table (1): Seasonable, unseasonable and annual yields of Balady lime as affected by NAA in months of 1999/2000 season.

NAA Conc. (ppm)	Seasonable yield (kg)							Total seasonable yield	
	July	August	September	October	November	December			
0.0	20.8	34.7	2.7	3.8	5.6	5.5	73.1		
400	14.7	31.9	2.2	3.7	5.0	5.4	62.9		
600	10.4	26.6	1.8	2.9	4.8	5.1	51.6		
800	8.8	24.2	1.7	2.8	4.5	5.0	47.0		
New LSD 5%	2.5	2.6	0.5	0.8	0.4	0.4	5.0		
NAA Conc. (ppm)	Unseasonable yield (kg)							Total unseasonable yield	Annual yield
	January	February	March	April	May	June			
0.0	3.6	4.5	3.2	2.9	1.7	0.8	16.7	89.8	
400	5.6	6.5	4.3	3.5	2.0	1.2	23.1	86.0	
600	6.2	7.7	4.8	3.9	2.4	1.5	26.5	78.1	
800	6.7	8.2	6.1	4.3	2.6	1.9	29.8	76.8	
New LSD 5%	0.6	1.0	1.0	0.6	0.3	0.4	3.4		

Table (2): Seasonable, unseasonable and annual yields of Balady lime as affected by NAA in months of 2000/2001 season.

NAA Conc. (ppm)	Seasonable yield (kg)							Total seasonable yield	
	July	August	September	October	November	December			
0.0	34.7	22.3	3.8	5.0	4.1	4.8	74.7		
400	29.4	20.2	3.1	3.2	3.2	3.3	62.4		
600	27.7	19.6	2.4	2.4	2.5	2.6	57.2		
800	27.4	19.3	2.0	1.8	2.1	2.3	54.7		
New LSD 5%	1.6	0.6	0.7	0.7	0.6	0.7	3.9		
NAA Conc. (ppm)	Unseasonable yield (kg)							Total unseasonable yield	Annual yield
	January	February	March	April	May	June			
0.0	3.6	4.0	3.3	2.3	1.3	0.7	15.2	89.9	
400	5.3	6.0	4.5	3.7	1.9	1.4	22.7	85.1	
600	6.5	6.9	5.5	4.3	2.4	1.9	27.5	84.7	
800	6.8	7.4	5.9	4.5	2.5	1.9	29.0	83.7	
New LSD 5%	1.0	0.7	0.9	0.5	0.5	0.5	3.9	4.0	

Table (3): Seasonable, unseasonable and annual yields expressed as number of fruits of Balady lime as affected by NAA in months of 1999/2000 season.

NAA Conc. (ppm)	Seasonable yield							
	July	August	September	October	November	December	Total seasonable yield	
0.0	1124	173.0	38.0	35.0	186.0	155.0	3418	
400	821.0	1497.0	79.0	131.0	160.0	142.0	2830	
600	554.0	1355.0	71.0	116.0	153.0	131.0	2380	
800	490.0	1312.0	64.0	104.0	143.0	122.0	2235	
New LSD 5%	67.0	92.0	10.0	13.0	11.0	10.0	255.0	
NAA Conc. (ppm)	Unseasonable yield							
	January	February	March	April	May	June	Total unseasonable yield	Annual yield
0.0	120.0	120.0	80.0	65.0	42.0	20.0	447.0	3865.0
400	200.0	180.0	110.0	80.0	56.0	32.0	658.0	3488.0
600	230.0	220.0	140.0	96.0	70.0	49.0	805.0	3185.0
800	250.0	240.0	165.0	100.0	76.0	55.0	886	3121.0
New LSD 5%	23.0	33.0	29.0	15.0	15.0	11.0	142.0	242.0

Table (4): Seasonable, unseasonable and annual yields expressed as number of fruits of Balady lime as affected by NAA in months of 2000/2001 season.

NAA Conc. (ppm)	Seasonable yield							Total seasonable yield	
	July	August	September	October	November	December			
0.0	1699.0	1333.0	220.0	175.0	130.0	120.0	3677.0		
400	1526.0	1056.0	140.0	115.0	100.0	80.0	3017.0		
600	1330.0	921.0	100.0	85.0	75.0	61.0	2572.0		
800	1306.0	904.0	75.0	60.0	60.0	52.0	2457.0		
New LSD, 5%	101.0	100.0	39.0	28.0	24.0	18.0	211.0		
NAA Conc. (ppm)	Unseasonable yield							Total unseasonable yield	Annual yield
	January	February	March	April	May	June			
0.0	105.0	110.0	90.0	70.0	30.0	15.0	420.0	4097.0	
400	180.0	170.0	120.0	90.0	42.0	30.0	632.0	3649.0	
600	250.0	206.0	150.0	108.0	59.0	42.0	815.0	3387.0	
800	270.0	225.0	170.0	115.0	70.0	46.0	896.0	3353.0	
New LSD, 5%	41.0	30.0	29.0	15.0	11.0	11.0	141.0	215.0	

satisfactory unseasonable yield in the periods from January to June. These results were the same in both seasons. These results confirmed the reversible relation existed between seasonable and unseasonable yield on the individual tree.

The effect of NAA on stimulating the naturally occurring fruit drop during the stages of heavy crop could explain the present study. In addition the important role of NAA on enhancing the activity of enzymes responsible for breakdown of pectic substances to soluble ones and the formation of abscission zone gave another explanation for the effect of NAA on increasing fruit drop.

These results are in agreement with those obtained by Josan and Sharma (1990), Ortola *et al.* (1991), Perez *et al.* (1994), Hartey and Sullon (1994) and Ibrahim *et al.* (2001).

2- Effect of fruit thinning with NAA on some physical and chemical properties of fruits:-

Application of NAA at 400 to 800 ppm was very effective in improving fruit weight in seasonable yield, while was responsible for reducing fruit weight in unseasonable yield (table, 5 & 6). The increase or the reduction of fruit weight was associated with increasing NAA concentrations. Generally speaking fruit weight and dimensions were higher in

unseasonable yield than in seasonable one. Fruit dimensions (width and height), juice % and fruit peel thickness were slightly affected with application of NAA. Fruit thinning with NAA 600-800 ppm was very beneficial in enhancing fruit quality in terms of increasing the total soluble solids and ascorbic acid and decreasing the total acidity. The promotion was positively correlated with increasing NAA concentrations without significant differences on such parameters between using 600 or 800 ppm NAA. The best results with regard to fruit quality was obtained due to spraying 600 ppm NAA. The improving effect of NAA on fruit quality was mainly attributed to its effect in reducing the yield and lowering the competition between fruits on sugars and other organic foods. The reduction on fruit weight of unseasonable yield in response to application of NAA might be attributed to its effect on increasing the number of fruits per tree.

These results are in harmony with those obtained by Gallasch (1988), El-Kassas *et al.* (1994), Rabe (1994) and Kanonich *et al.* (2000).

Conclusion

It is advised to spray the Balady lime trees once on the first week of May with 600 ppm NAA accompanied with soil addition of 1000 g N /tree at two unequal batches (300 g N /tree in the mid of Jan and 700 g N /tree in the last

Table (5) : Effect of thinning with NAA on some physical and chemical properties of fruits of the seasonable yields of Balady lime trees in 1999/2000 and 2000/2001 seasons.

NAA Conc (ppm)	First season							
	Fruit weight (g)	Fruit width (cm)	Fruit height (cm)	Juice %	Peel thick. (cm)	TSS %	Total acidity %	Vitamin C (mg/100ml juice)
0.0	22.5	3.39	3.80	36.00	0.158	8.20	7.93	49.58
400	22.9	3.42	3.89	36.28	0.162	8.27	7.91	53.69
600	24.8	3.52	3.92	37.99	0.164	8.45	7.78	57.80
800	25.0	3.59	4.08	38.17	0.165	8.60	7.72	57.92
New LSD at 5%	2.0	NS	NS	NS	NS	0.11	0.09	2.92
Second season								
0.0	24.43	3.43	3.89	37.90	0.160	8.73	8.02	57.43
400	25.97	3.55	3.96	39.03	0.166	8.82	7.90	60.01
600	26.29	3.60	3.99	40.15	0.171	8.99	7.75	61.84
800	27.42	3.64	4.04	40.82	0.172	9.02	7.70	62.91
New LSD at 5%	1.22	NS	NS	1.11	NS	0.12	0.10	2.11

Table (6) : Effect of thinning with NAA on some physical and chemical properties of fruits of the unseasonable yields of Balady lime trees in 1999/2000 and 2000/2001 seasons.

NAA Conc (ppm)	First season							
	Fruit weight (g)	Fruit width (cm)	Fruit height (cm)	Juice %	Peel thick. (cm)	TSS %	Total acidity %	Vitamin C (mg /100g pulp)
0.0	43.3	4.3	4.2	44.0	0.225	8.00	7.77	60.0
400	39.9	4.1	4.0	45.0	0.228	8.20	7.44	63.9
600	40.7	4.0	3.9	45.3	0.236	8.56	7.30	64.0
800	41.2	3.9	3.8	45.6	0.245	8.70	7.20	64.5
New LSD at 5%	2.1	NS	NS	NS	NS	0.15	0.14	2.9
Second season								
0.0	42.6	4.3	4.1	43.0	0.222	8.10	7.44	57.9
400	39.7	4.0	3.9	43.2	0.253	8.20	7.42	60.2
600	39.5	4.0	3.7	43.2	0.255	8.33	7.26	60.2
800	38.1	4.0	3.6	43.5	0.255	8.63	6.81	60.6
New LSD at 5%	1.8	NS	NS	NS	NS	0.11	0.11	2.1

week of August) for obtaining fruits all over the year and improving fruit quality

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محاولة للحصول على ثمار ليمون بلدي مالح طوال العام عن طريق خف الثمار بواسطة نقتالين حامض الخليك

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أجريت هذه الدراسة خلال موسم ١٩٩٩ / ٢٠٠٠ ، ٢٠٠٠ / ٢٠٠١ على ٢٤ شجرة ليمون بلدي مالح عمرها ٢٢ سنة كمحاولة للحصول على ثمار ليمون بلدي طوال العام وكذلك لتحسين جودة الثمار عن طريق خف الثمار بتركيز صفر ، ٤٠٠ ، ٦٠٠ ، ٨٠٠ جزء في المليون من نقتالين حامض الخليك مرة واحدة في مرحلة الحمل الغزير للثمار (أول مايو) وقد تم تسميد الأشجار بمعدل ١٠٠٠ جرام ازوت للشجرة على أساس ٣٠٠ جرام ازوت للشجرة في منتصف يناير ، ٧٠٠ جرام ازوت للشجرة في الأسبوع الأخير من أغسطس.

أشارت نتائج الدراسة ان خف الثمار باستخدام نقتالين حامض الخليك بتركيز ٤٠٠ - ٨٠٠ جزء في المليون كان فعالا في تقليل المحصول الأساسي في صورة وزن وعدد ثمار للشجرة في الفترة من يوليو حتى ديسمبر وكذلك المحصول الكلي الأساسي وفي زيادة محصول الترجيع في الفترة من يناير حتى يونيو ومحصول الترجيع الكلي وقد أدت معاملات الخف الى نقص في المحصول السنوي وكان تأثير نقتالين حامض الخليك يتوقف على التركيز المستخدم منه وبمكسر القول عموما بأن وزن وابعاد الثمرة كان مرتبطا بمحصول الترجيع مقارنة بالمحصول الأساسي ولقد صاحب زيادة التركيز المستخدم من نقتالين حامض الخليك زيادة في وزن الثمرة في المحصول الأساسي وفي نقص وزنها في محصول الترجيع. وكان هناك تأثير طفيف في ابعاد الثمرة ، نسبة العقد ، سمك القشرة عند زيادة التركيز المستخدم من نقتالين حامض الخليك من ٦٠٠ الى ٨٠٠ جزء في المليون وكان هناك تحسن ملحوظ في خصائص الجودة الكيميائية للثمار متستلا في زيادة نسبة المواد الصلبة الذائبة الكلية وفيتامين ج وفي نقص الحموضة الكلية بزيادة التركيز المستخدم من نقتالين حامض الخليك ولم يكن هناك تأثير على هذه المقاييس عند رفع التركيز المستخدم من نقتالين حامض الخليك من ٦٠٠ الى ٨٠٠ جزء في المليون.

كان رش أشجار الليمون البلدي المالح مرة واحدة في الأسبوع الأول من مايو بتركيز ٦٠٠ جزء في المليون من نقتالين حامض الخليك وتسميد الأشجار بمعدل ١٠٠٠ جرام ازوت للشجرة (مرتان على أساس ٣٠٠ جرام ازوت للشجرة في منتصف يناير ، ٧٠٠ جرام ازوت للشجرة في الأسبوع الأخير من أغسطس) ضروريا للحصول على محصول ليمون بلدي طوال العام وتحسين خصائص الجودة.