ALTERNATE BEARING OF BALADY MANDARIN (*Citrus reticulate*, L.) IN RELATION TO SOME HORTICULTURAL PRACTICES AND SOME GROWTH REGULATORS

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ABSTRACT

A field experiment was carried out at Biyala city, Kafr El-Sheikh Governorate during four successive seasons (1998, 1999, 2000 and 2001) to study the effect of some horticultural practices and some growth regulators on alternate bearing habit of Balady mandarin trees. Thin pruning, trunk girdling, heavy N fertilization, spraying NAA at 300 ppm and GA_3 at 100 ppm were applied to Balady mandarin trees. All treatments could regulate cropping during the four successive seasons as compared to control. All treatments increased the average yield of the two following seasons also all practices applied gave significant increase of the T.S.S., Vitamin C and total sugars content of the fruits compared to the control. Whereas, all treatments applied significantly decreased the total acidity.

Spraying Balady mandarin with GA_3 at 100 ppm during the stage of flower bud formation of the "On"-year gave the least alternate bearing value with regular bearing in the following years.

Key words: Alternate bearing, Balady mandarin, GA_3, NAA, thinning and girdling.

INTRODUCTION

The phenomenon of alternate bearing is common in many fruit species, Balady mandarin trees exhibited the alternate bearing habit. Ahmed (1960) and Saleh (1987) found that the alternate bearing phenomenon occurs with eight mandarin varieties. Variation in the extent of cyclic fluctuations are influenced by climatic factors and by the genetic characteristics of the variety (Singh *et al.*, 1962). Attempts to induce sufficient vegetative growth early in the "On" year by heavy N application were carried by Zidan *et al.* (1968) on Balady mandarin and Lenz (1970) on Washington navel orange. They stated that a combination of high N plus fruit thinning is recommended during on-year for regular yield.

Pruning and girdling are means used to correct alternate bearing during on-year crop, Hayes (1970), Iwahori *et al.* (1975), Monselise *et al.* (1983) and Cohen (1984) Autumn girdling and GA_3 treatments were both effective and additive in increasing starch contents of Shamouti orange leaves. GA_3 depressed flower bud formation of next On-year flowering, Goldschmidt *et al.* (1985). Coggins *et al.* (1960 a, b), (1962), Moss (1978), Marino and Greene (1981), Guardiola *et al.* (1982) and Tromp (1983). Inhibition of flower bud formation during the time of induction were

reported by several investigators; Guttridge (1962), Monselise and Halevy (1964), Marcella and Sironval (1963). Goldschmidt and Monselise (1970) and Guardiola *et al.* (1979).

The main objective of this investigation is to control alternate bearing of Balady mandarin through certain horticultural practices and inhibiting the formation of excessive flower buds during the induction period of subsequent expected On-year crop.

MATERIALS AND METHODS

This investigation was undertaken during four successive growing seasons of 1998, 1999, 2000 and 2001 on orchard of Balady mandarin (*Citrus reticulata*, L.) located at Biyala city, Kafr El-Sheikh Governorate where the soil is clayey and slightly alkaline (pH 8.3). The trees were 9 years old on sour orange rootstock planted at 5 x 5 m apart. All trees received the normal cultural practices. The experimental trees were selected to be in the status of "Off" going to "on" year. The physical and chemical properties of the soil are presented in Table (1).

Table (1): Measurements of physical and chemical soil properties of the orchard soil.

Soil properties	Measurements
Physical properties	
Sand %	24.2
Silt %	31.9
Clay %	43.9
Chemical properties	
Soluble cations (meq/100 g soil)*	
Ca^{++}	0.530
Mg^{++}	0.302
Na^{+}	3.530
K^{+}	0.160
Soluble anions (meq/100 g soil)*	
CO_3^{-}	-
HCO_3^{-}	0.415
Cl^{-}	0.688
SO_4^{--}	3.563
Soil pH*	8.3
Total soluble salts %	0.150
Organic matter %	2.02
Total N (mg/100 g soil)	150.55
Soluble N (mg/100 g soil)	4.52
Total P (mg/100 g soil)	30.21
soluble P (mg/100 g soil)	3.01
Total K (mg/100 g soil)	170.11
Soluble K (mg/100 g soil)	1.10

* Soluble cations and anions along with pH determined in 1: 5 soil water extract.

For this study 24 trees of Balady mandarin were selected on the basis of similarity in bearing status during the previous season and on flowering intensity during spring of 1997 season. The six treatments were replicated four times in a completely randomized block design.

The following treatments were tried:

1. Control (untreated).
2. Shoot thinning by removing 1 kg of fresh bearing shoots from all direction of each tree on 1st May 1998 and 2000 "On" year trees.
3. Tree trunk girdling on 25th December 1998 and 2000 seasons. Such girdling was carried out by removing a narrow ring from the bark entirely (2 mm width) using double blade knife. Trunk girdling was performed above bud union and below branching of the main limbs.
4. Heavy nitrogen fertilization with ammonium nitrate (33.5% N) applied in 1998 and 2000 in three equal doses of 1.49 kg each during March, May and July (1500 g N/tree/year).
5. Spraying the trees with NAA at 300 ppm in early May 1998 and 2000 seasons.
6. Spraying the trees with 100 ppm gibberellic acid during the period of flower bud induction on 25th December 1997 and 1999 seasons.

During the four seasons the following characteristics were recorded:

1. Yield as fruit weight per tree was recorded at harvest time.
2. The alternate bearing value for each of the two seasons was calculated according to Singh (1948) by dividing the difference between yield of the two following seasons by the sum of the production of them. Equal yields will show a (zero) value while complete alternation has a value of (1).
3. A sample of 16 fruits were collected from each tree at harvest time at random for determination of total acidity %, TSS %, V.C and total sugars % according to A.O.A.C. (1975).

All data were subjected to statistical analysis according to Steel and Torrie, 1982.

RESULTS AND DISCUSSION

Fruit yield:

It is clear from Table (2) that the control trees produced the highest yield in both seasons 1998 and 2000 as compared to the values in different treatments. Meanwhile the control trees in both seasons 1999 and 2001 were significantly lower than all tested treatments.

Table (2): Effect of different treatments on the yield of Balady mandarin.

Treatments	Yield (kg/tree)			
	1998	1999	2000	2001
Control	48.8	24.3	54.5	28.4
Shoot thinning	36.7	58.3	31.4	53.2
Trunk girdling	41.4	59.6	39.5	56.5
1500 g/N/tree	35.6	54.4	35.0	57.0
NAA 300 ppm	39.20	49.9	40.3	53.7
GA_3 100 ppm	39.2	47.9	40.4	53.6
L.S.D. at 5%	3.7	4.5	3.9	4.2

Shoot thinning of some flowering branches one month after anthesis may regulate the alternate bearing behaviour. These results are in agreement with the work carried out by Hayes (1970) who mentioned that the heavy crop of citrus trees uses up large amounts of food leaves as to interfere with vegetative growth. If by pruning, a considerable part of bearing area is removed, the fruit yield is reduced and the dwarfing effect of the heavy crop on vegetative growth may be avoided. He added, pruning part of the bearing branches in winter, before the on year also prevents heavy bearing and improve light cropping of the next year. El-Kassas *et al.* (1994b) found that shoot thinning of some flowering branches did not induce appreciable alteration in fruit yield trend as compared with the untreated control Balady mandarin trees. Lewis and McCarty (1973) reported that occasionally, pruning is an attempt to force the tree to produce new productive fruit wood.

Girdling of the main trunk of Balady mandarin tree during December 25th 1998 and 2000, altered the biennial bearing habit as compared to the untreated control. Such data might be due to increasing starch and plant growth hormones above the ring. Schaffer *et al.* (1985) compared prebloon girdling of "Murcott" tangerine and "Shamouti" orange. They found significant increase in fruit in "Shamouti" and smaller effects on "Murcott" with regard to girdling treatment. Goldschmidt *et al.* (1985) reported that girdling of "Murcott" branches during October increased starch content of leaves and flowers by 2-3 fold as compared to ungirdled branches. Monselise *et al.* (1983) girdled the scaffold branches of Michel tangerine trees once in the autumn. They found that individual branches could be driven into opposite phases of alternate bearing which continued at least 3 successive years. El-Kassas *et al.* (1994b) reported that trunk girdling during December

25th could regulate cropping in Balady mandarin trees during four successive seasons as compared to untreated control.

Heavy nitrogen fertilization during 1998-2000 on flowering seasons altered the alternate bearing habit as compared to the control. Zidan *et al.* (1968) on Balady mandarin found that heavy N plus fruit thinning is recommended during On-year for regular yield. El-Kassas *et al.* (1994b) on Balady mandarin reported that heavy N application could regulate cropping during the four successive seasons as compared to untreated control.

NAA at 300 ppm in early May of the "On" years 1998-2000 and GA_3 at 100 ppm in December 1997-1999 regulated the bearing.

These results are in agreement with early findings by Reuther *et al.* (1973), Smith (1976) and Monselise and Goldschmidt (1982) on some mandarin cultivars. They suggested that the absence of fruit in the off year was due to lack of flower bud formation during the previously high yielding On-year, rather than to poor set of flowers. Nagasawa *et al.* (1971) found that the application of NAA at 300 ppm to Satsuma orange 30 days after full bloom was most effective on fruit thinning when applied on smaller, lighter fruit with few leaves and low C/N ratio. Jones *et al.* (1979) working on Kinnow mandarin, found that application of NAA in the on year thinned the fruit and resulted in increasing fruiting the next year. Evans (1980) who demonstrated that GA_3 among other plant growth stimuli may interact with other endogenous regulators to control the evocation of flowering. In addition, Freeman and Nichoils (1981) and Saleh (1987) observed that GA_3 sprayed in mid winter, reduced the ratio of floral to vegetative shoots and number of flowers was reduced by over 50%.

Soliman (1992) on Balady mandarin and Valencia orange trees and El-Kassas *et al.* (1994a) on Balady mandarin, found that NAA at 250 or 400 ppm and GA_3 at 200 ppm were effective in reducing the amplitude of alternate bearing along next four seasons. Data in Table (3) indicate that all treatments increased the average yield of the two following seasons as compared to the control. These results are in line with those obtained by Soliman (1992) on Balady mandarin and Valencia orange trees and El-Kassas *et al.* (1994a, 1994b) on Balady mandarin.

Data illustrated in Table (4) show that the values of alternate bearing which were calculated using the formula of Singh (1948). all treatments used tended to decrease the alternate bearing value as compared to the control. In this respect spraying GA_3 at 100 ppm showed the lowest values. Similar results were reported by Moss *et al.* (1978) on late Valencia oranges, Wheaton (1983) on Dancy tongarines and Murcott tangors, Soliman *et al.* (1992) on Balady mandarin and Valencia orange trees, El-Kassas *et al.*

(1994a, 1994b) on Balady mandarin and Mikhael (2001) on Japanese persimmon.

Table (3): Effect of different treatments on Balady mandarin on the average yield (as kg/tree) of the two following seasons.

Treatments	Average yield of seasons 1998, 1999	Average yield of seasons 2000, 2001
Control	36.55	41.45
Shoot thinning	47.5	42.3
Trunk girdling	50.5	48.0
1500 g/N/tree	45.0	46.0
NAA 300 ppm	44.55	47.0
GA_3 100 ppm	43.55	47.0
L.S.D. at 5%	4.3	4.1

Table (4): Effect of different treatments on the alternate bearing value of Balady mandarin of the two following years of (1998 and 1999) and (2000 and 2001).

Treatments	1998 and 1999	2000 and 2001
Control	0.335	0.315
Shoot thinning	0.230	0.258
Trunk girdling	0.171	0.188
1500 g/N/tree	0.222	0.239
NAA 300 ppm	0.120	0.142
GA_3 100 ppm	0.100	0.140

Equal yields show a zero value, while complete alternation has a value of (1).

Fruit quality:

According to Tables (5), (6), (7) and (8), all the used treatments significantly decreased the total acidity in juice of Balady Mandarin compared to the untreated ones. Whereas all the used treatments significantly increased TSS, vit. C (mg/100 ml and total sugars in juice of Balady mandarin than the untreated trees. These results were in harmony with those obtained by Coggins *et al.* (1962), Galliani *et al.* (1975), Wheaton (1983), Ghaly (1987), El-Kassas *et al.* (1994a), (1994b) and Mikhael (2001). Generally, all used treatments reduced the yield of the "On" year trees and regulate the bearing of the "Off" year trees. Thus fruit quality of Balady Mandarin improved.

Table (5): Effect of different treatments on citric acid content of Balady mandarin fruit.

Treatments	Acidity percentage				
	1998	1999	2000	2001	Mean
Control	1.310	1.360	1.219	1.290	1.295
Shoot thinning	1.176	1.128	1.153	1.148	1.151
Trunk girdling	1.272	1.192	1.203	1.178	1.211
1500 g/N/tree	1.184	1.176	1.164	1.159	1.171
NAA 300 ppm	1.032	1.072	1.043	1.053	1.05
GA_3 100 ppm	1.293	1.224	1.205	1.200	1.231
L.S.D. at 5%	0.016	0.130	0.004	0.080	

Table (6): Effect of different treatments on total soluble solids of fruit-juice of Balady mandarin fruit.

Treatments	T.S.S.%				
	1998	1999	2000	2001	Mean
Control	11.3	11.5	11.7	11.6	11.53
Shoot thinning	12.9	12.7	12.6	13.2	12.85
Trunk girdling	13.3	12.8	12.9	12.7	12.93
1500 g/N/tree	13.5	13.2	13.4	12.9	13.2
NAA 300 ppm	12.3	12.5	12.2	12.4	12.35
GA_3 100 ppm	12.7	12.6	12.8	12.5	12.65
L.S.D. at 5%	0.90	0.97	0.48	0.7	

Table (7): Effect of different treatments on ascorbic acid content (mg/100 ml juice) of Balady mandarin fruit juice.

Treatments	Ascorbic acid content (mg/100 ml juice)				
	1998	1999	2000	2001	Mean
Control	39.5	38.3	38.6	39.2	38.9
Shoot thinning	42.9	42.7	42.3	42.2	42.53
Trunk girdling	41.7	41.9	39.4	39.9	40.73
1500 g/N/tree	40.6	40.8	41.7	41.7	41.2
NAA 300 ppm	41.8	41.5	39.9	40.5	40.93
GA_3 100 ppm	40.9	40.6	39.5	40.6	40.4
L.S.D. at 5%	0.96	2.20	0.75	0.69	

Table (8): Effect of different treatments on the subsequent total sugars trend of Balady mandarin juice.

Treatments	Total sugars %				
	1998	1999	2000	2001	Mean
Control	9.36	10.05	9.65	9.20	9.57
Shoot thinning	9.66	10.44	10.01	10.58	10.17
Trunk girdling	10.45	10.85	10.45	10.18	10.48
1500 g/N/tree	9.92	10.54	10.08	9.95	10.12
NAA 300 ppm	9.50	10.25	10.21	10.04	10.00
GA_3 100 ppm	9.57	10.88	9.93	9.97	10.09
L.S.D. at 5%	0.039	0.20	0.239	0.74	

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الملخص العربى

تبادل الحمل فى اليوسفى البلدى وعلاقته ببعض معاملات الخدمة البستانية وبعض منظمات النمو

عبدالله عبد الحميد الحسينى

أجريت هذه التجربة فى مركز بيلا محافظة كفرالشيخ خلال أربعة مواسم من عام ١٩٩٨ حتى عام ٢٠٠١ لدراسة بعض العمليات الزراعية وبعض منظمات النمو على عادة تبادل الحمل فى اليوسفى البلدى. أجرى تقليم الخف لبعض الأشجار وحلقت أخرى وأجرى التسميد الآزوتي الغزير والرش بنفثالين حمض الخليك بتركيز ٣٠٠ جزء فى المليون بعد العقد بحوالى شهر فى سنتى الحمل الثقيل المتوقع والرش بحمض الجبريلك وقت تحول البراعم الى براعم زهرية لتقليل الأزهار فى سنتى الحمل الغزير المتوقع باستخدام تركيز ١٠٠ جزء فى المليون وكانت النتائج المتحصل عليها خلال أربعة مواسم من عام ١٩٩٨ حتى عام ٢٠٠١ كالاتى:

١ - أدت كل المعاملات إلى تنظيم المحصول خلال سنوات الدراسة.

٢ - أدت كل المعاملات إلى زيادة متوسط المحصول عامى ٩٨-٩٩ وكذلك عامى ٢٠٠٠-٢٠٠١ بالمقارنة بالكنترول.

٣ - أدت كل المعاملات إلى زيادة محتوى الثمار من المواد الصلبة الذائبة وفيتامين C والسكريات بينما أنخفض محتوى الثمار من حمض الستريك.

٤ - الرش بحمض الجبريلك بتركيز ١٠٠ جزء فى المليون أثناء مراحل تحول البراعم سنتي الحمل الغزير أعطى أقل قيمة تبادل الحمل مع تنظيم الحمل فى سنتى الدراسة عن بقية المعاملات الأخرى وتعتبر افضل معاملة.