EFFECT OF PRUNING SEVERITY ON GROWTH, YIELD AND FRUIT QUALITY OF BALADY MANDARIN TREES (*Citrus reticulata* Blanco.)

By

HANY MOSTAFA KAMEL ALI

B.Sc. Agric. Sci. (Pomolgy), Fac. Agric., Cairo Univ., Egypt, 1998
M.Sc. Agric. Sci. (Pomolgy), Fac. Agric., Cairo Univ., Egypt, 2004

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In

Agricultural Sciences
(Pomology)

Department of Pomology
Faculty of Agriculture
Cairo University
EGYPT

2009

APPROVAL SHEET

EFFECT OF PRUNING SEVERITY ON GROWTH, YIELD AND FRUIT QUALITY OF BALADY MANDARIN TREES (*Citrus reticulata* Blanco.)

Ph. D. Thesis
In
Agric. Sci. (Pomology)

By

HANY MOSTAFA KAMEL ALI

B.Sc. Agric. Sci. (Pomolgy), Fac. Agric., Cairo Univ., Egypt, 1998
M.Sc. Agric. Sci. (Pomolgy), Fac. Agric., Cairo Univ., Egypt, 2004

Approval Committee

Dr. Salama Eid Salem.....
Head Researcher of Pomology, Hort. Res. Inst., Agric. Res. Center

Dr. Mohamed Ahmed Fayek .....
Professor of Pomology, Fac. Agric., Cairo University

Dr. Gamal Mohamed Mahmoud Hasseb.....
Professor of Pomology, Fac. Agric., Cairo University

Dr. Ahmed Tawfik Salem.....
Professor of Pomology, Fac. Agric., Cairo University

Date: / / 2009

SUPERVISION SHEET

EFFECT OF PRUNING SEVERITY ON GROWTH, YIELD AND FRUIT QUALITY OF BALADY MANDARIN TREES (*Citrus reticulata* Blanco.)

Ph.D. Thesis
In
Agric. Sci. (Pomology)

By

HANY MOSTAFA KAMEL ALI

B.Sc. Agric. Sci. (Pomolgy), Fac. Agric., Cairo Univ., Egypt, 1998
M.Sc. Agric. Sci. (Pomolgy), Fac. Agric., Cairo Univ., Egypt, 2004

SUPERVISION COMMITTEE

Dr. Ahmed Tawfik Salem
Professor of Pomology, Fac. Agric., Cairo University

Dr. Gamal Mohamed Mahmoud Hasseb
Professor of Pomology, Fac. Agric., Cairo University

Name of Candidate: Hany Mostafa Kamel Ali **Degree:** Ph. D.
Title of Thesis: Effect of pruning severity on growth, yield and fruit quality of Balady mandarin trees (*Citrus reticulata* Balnco).
Supervisors: Dr. Ahmed Tawifk Salem
Dr. Gamal Mohamed Mahmoud Hasseb
Department: Pomology **Approval: / /2009**

ABSTRACT

This investigation was carried out through two successive seasons (2006/07 and 2007/08) on 10-year old trees of Balady mandarin to evaluate the response of trees to different degrees of pruning severity at El-Khatatba region Giza governorate. Different pruning treatments significantly improved vegetative growth of different growth cycles compared to the control trees. Moderate pruning treatment was superior and produced the highest number of flowers. Pruning applications had positively effect on initial fruit set, reducing fruit drop and fruit retention percentage of the both seasons. Moderate and severe pruning treatments significantly enhanced the fruit growth. Different pruning treatments insignificantly enhanced the number of white roots compared with control, and light and moderate pruning achieved highest value, in asddition length of white roots of trees subject to severe pruning was higher than that obtained to from the other treatemnts. In the first year after pruning treatments, average number of white roots was insignificantly increased by increasing severity of pruning treatments and the unpruned trees achieved the highest average number and length of new roots of the first year after pruning treatments was significantly increased by moderate pruning compared with the control trees, which recorded the shortest new roots. Moderated and sever pruning treatments resulted in significantly the highest average of yield (as kg or number of fruits/tree) in both seasons compared with control trees while in the first year after pruning treatments, the yield (as kg or number of fruits/tree) linearly decreased with increasing pruning treatments compared with control trees, which had the highest value. The percentages of high and the first grade fruits significantly increased by moderated pruning treatment for both seasons. Severe pruning and control trees treatments during the 1st and 2nd seasons achieved the highest significant of the second grade fruits percentage. Moderate and severe pruning treatments achieved the highest fruit quality, which could be more suitable for export. Moderate pruning accelerated the process of flower buds initiation of Balady mandarin trees.

Key Words: Pruning - Growth – Yield - Flower bud initiation – Balady mandarin.

DEDICATION

First and forever, ultimate thanks are due to ***Allah****, who without his aid this work could be not done.*

I dedicate this work to whom my heart felt thanks; to my waif ***Azhar*** *and my son* ***Mostafa*** *for their patience and help, as well as to my* ***Mother*** *and brothers* ***Reda & Mohamed*** *for all the support they lovely offered along the period of my post graduation.*

ACKNOWLEDGEMENT

It is a great pleasure for me to express my gratitude and appreciation to ***Dr. Ahmad Tawfik Salem,*** *Professor of Pomology, Faculty of Agriculture, Cairo University, for his inspiration, his supervision, reviewing the manuscript, valuable guidance, kind help and continuous encouragement throughout the course of this study.*

I wish to express my profound gratitude to ***Dr. Gamal Mohamed Mahmoud Hasseb,*** *Professor of Pomology, Faculty of Agriculture, Cairo University, for proposing the problem, sincere advice, constant guidance active, providing the needed apparatus and stimulating criticism during the whole investigation.*

Grateful acknowledgement is due to ***Eng. Samir El seman,*** *for offering every possible help and providing the plant material in this work*

I'm also extending my deep gratitude for all members of Pomology Department, Faculty of Agriculture, Cairo University., who helped in many ways to make thesis possible.

CONTENTS

!

INTRODUCTION

The importance of citrus growing in the world has been increasing steadily. This is reflected not only in the amount of production and export, but also in its relative position in the world fruit production. In Egypt citrus are considered to be one of the major fruit crops on cultivated area, ranked the first one in Egypt. Citrus cultivation has doubled in area over the past 25 years and Egypt ranks as 11^{th} , 8^{th} respectively based on area harvested (Ha) and yield per hectar (Kg/Ha) on world wide at year of 2007 (according to the statistics of food and agriculture organization of the united nations in 2009) (Table 1).

Table 1. World wide area and production of citrus fruits in 2007 (Area harvested: Hectare., yield per hectare: Kg/Ha)

Country	Area harvested (Hectare)	Yield (Kg/Ha)
China	86250	15165.2
Japan	9000	17333.3
Iran, Islamic Rep of	5000	13600.0
Italy	1500	20000.0
U. S. A	1050	28571.4
Morocco	1100	9090.90
Spain	1100	15000.0
Israel	1000	15000.0
South Africa	380	18421.1
Turkey	200	12995.0
Egypt	170	14705.9
Australia	80	12500.0

Source: Statistics of food and agriculture organization of the united nations in 2009

During the last decade, new orchards were established especially in the "New Lands" outside the Delta and there has been more than 10.000 ha of new plantations in the desert outside the Nile valley.

More than one fourth of the total citrus production comes now from the "New Lands" in the desert. Approximately half of the total acreage in the country is cultivated by large-scale farms (more than three ha), the other half is cultivated by small-scale growers. Export volumes have more than doubled in the same period (Fig. 1). More than 600,000 tons were exported in 2005 and it is expected that Egypt will export close to 1 million tons of fresh citrus fruits by the year 2010 (Joachim, 2006).

The local mandarin variety planted in Egypt is named “Youseffy affendy” or “Youseffy balady” which belongs to common Mediterranean mandarin (*Citrus reticulata* Blanco.) (El-Azzoni and El-Barkouki, 1961). The trees are small, reaching 4m hight, the flowers are solitary or in small corymbs, fruits are small to medium, globes contain seeds, easy to peel, thin rind surrounding segments filled with pulp vesicles, sweet and juicy and harvest in winter. “Youseffy affendy” fruits are commercially important as many species are cultivated for their fruit, which are eaten fresh or pressed for juice.

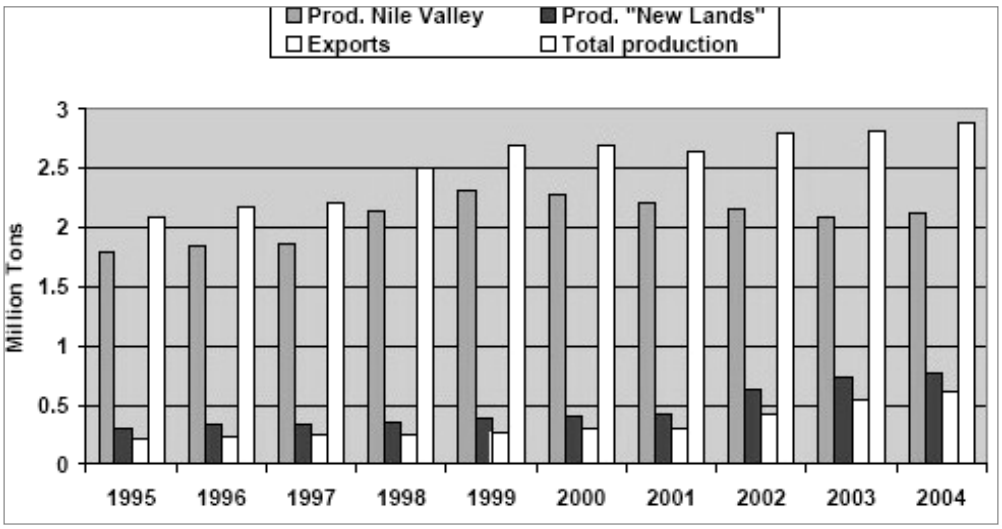

Fig. 1. Citrus production and exports

The total acreage of mandarin and production in Egypt on 2007 is about 37000 hectare and 17837.8 (kg/ha) respectively and Egypt ranked 7th, 8th based on area harvested (ha) and Yield per hectar (kg/ha) on world wide at year of 2007 (Tables 2 and 3) (FAO, 2009), and ranked second after oranges in Egypt citrus industry. The main reasons for the low productivity are inappropriate cultivation practices such as old trees, lack of regular pruning, off-type cultivars, and poor irrigation practices.

Pruning of fruit is horticulture practice and well known for a long time. Pruning of citrus may produce a strong and well balanced framework of scaffold branches capable of supporting large and healthy foliage for a good fruit yield during the productive life of the tree (Reuther, 1973).

Citrus trees are a perennial crop. As long as they remain healthy, they can flower and fruit for years on end, sometimes for as long as twenty or thirty years. However, if the trees are not maintained at a proper size, the height and canopy shape of mature trees in a citrus orchard will not be uniform and the branches will be too crowded. In a crowded orchard, close canopies shaded the lower branches, impeded soil cultivation, fertilizer, pesticide application and diseases or pests can spread quickly. In plant density orchard fruit quality tends to be poor, and trees may not bear fruit every year.

A proper training and pruning program is essential for the maintenance of a healthy, productive citrus orchard. All cultivated citrus species are evergreen trees, with one exception (trifoliate orange:

Table 2. World wide area and production of mandarin fruits in 2007 (Area harvested: hectare., yield per hectare: kg/ha)

Country	Area harvested (hectare)	Yield (kg/ha)
China	1411000	10029.7
Spain	125000	16645.6
Brazil	61000	20836.1
Japan	51000	16725.5
Pakistan	50000	12800.0
Turkey	30800	23986.6
Islamic rep of Iran	45000	15600.0
Egypt	37000	17837.8
Italy	35829	19613.5
Argentina	32000	16250.0
Morocco	27000	17777.8
U. S. A	18000	18222.2
Israel	5320	30075.2
South Africa	5100	26470.6
Australia	4650	22258.1

Source: Statistics of food and agriculture organization of the united nations in 2009

Poncirus trifoliata Raf.). Neglected trees tend to have overgrown tops and produce crowded shoots.

In a few years, the canopy becomes very dense and grows into a dome. Branches in the interior may die from lack of sunlight. The tree will bear fruit only on the surface of the canopy, and will become progressively less productive (FFTC, 2005).

Good management therefore dictates the need to prune before the occurrence of these undesirable effects. Pruning should therefore be limited to that required for future canopy bearing surface development and for the conduct of efficient cultural and harvesting operations and the response to pruning depends on several factors

Table 3. Area and production quantity of citrus fruits and mandarin in Egypt in 2007 (area harvested: hectare., production quantity: tonnes, yield per hectare: kg/ha)

Years	Area harvested (Hectare)	Production quantity (Tonnes)	Yield (Kg/Ha)	Area harvested (Hectare)	Production quantity (Tonnes)	Yield (Kg/Ha)
		Citrus fruits			**Mandarin**	
2000	172	3100	18023.2	35000	481182	13748.0
2001	163	2169	13306.7	35840	564851	15760.3
2002	163	2400	14723.9	36361	601698	16547.8
2003	163	2400	14723.9	37481	612556	16343.1
2004	168	2500	14880.9	37898	661271	17448.7
2005	168	2500	14880.9	38000	665000	17500.0
2006	170	2500	14705.9	38500	670000	17402.6
2007	170	2500	14705.9	37000	660000	17837.8

Source: Statistics of food and agriculture organization of the united nations in 2009

including variety, tree age and vigor, fruiting habits, growing conditions, and production practices (Tucker *et al.* 1992).

Depending on the aforementioned introduction, the present investigation was outlined to study the effect of pruning severity on growth, yield and fruit quality of Balady mandarin trees in order to attain the suitable pruning technique gain higher production with good fruit quality.

REVIEW OF LITERATURE

Hereinafter, a complete review of the available literature about the effect of type of pruning on vegetative growth, flowering behaviour, fruit-set and fruit quality of citrus and other fruit trees. Literature concerned in this study will be reviewed under the following topics.

1. Vegetative growth

Vegetative growth in citrus trees, like other evergreen subtropical fruits trees, is cyclic and is produced in distinct flushes. Two to five (usually three) distinct flushes of growth yearly under the A.R.E. conditions, the spring flashes are most important (El-azzony, 1967 and Ahmed, 1974). The benefits of pruning on citrus trees have been illustrated by several investigations, which studied the effect of pruning treatments (severity, type, timing and in combination with other treatments) on vegetative growth (in terms of shoot length, number of shoots, leaf area, trunk growth and tree height) of Citrus sp., and there were different results about this subject.

Concerning the effect of severity of pruning treatments, it was found that, light pruning gave the highest tree growth of grapefruit and lemon trees throughout the 1st year (Cameron and Hodgson, 1941). Similarly, light pruning gave the highest total length flushes and leave area for fifteen-year-old trees of the 'Harumi' (*Citrus* sp.) and Satsuma trees (*Citrus unshiu*) cv. Oiwa (Tsuda *et al.* 1981 and Banno *et al.* 2005).

Hassan *et al.* (1992) reported that pruning regimes (removal of lower 1/3 branches and middle 1/3 branches from both sides, central top) of Balady mandarin trees significantly enhanced the vegetative growth. In addition, severe pruning (leaving 50 cm of the secondary shoots of Kagzi lime (*Citrus aurantifolia*) from the base or pruning 1/2 of the branch length of Tahiti lime (*Citrus latifolia* Tan) had caused a significant increase of branch length and number of new shoots, leaf area, canopy surface area and diameter and number of branches per plant (Rojas, 1997 and Khan and Syamal, 2003).

On the other hand, Dubrovickaja and Krenke (1958) on lemon trees and Iwasaki (1959) on Sastuma orange trees proved that, shoot growth of lemon trees and number of shoots of Sastuma orange trees was depressed by pruning treatments. Furthermore, effects of pruning treatments on growth were generally not significant, except with rejuvenation pruning (severe pruning involving the removal of all old and weak wood) which markedly reduced growth in the first year after pruning (Leyva and Alvarez, 1987).

Many investigations ensured that, mechanical pruning improved vegetative growth of different citrus trees. Valencia orange and Duncan grapefruit trees which were topped or headed back, were in a more vigorous condition than untopped one (Kretchman and Jutras 1964). Moreover, pruning stimulated shoot growth and vegetative growth of valance orange and lemon trees (Borroto *et al.* 1978 and Ruknidinov, 1985).

This observation in consistent with which reported by Blandini and Raciti (1980) as well as Joubert *et al.* (2000) on different citrus