

**A MODEL FOR USING IRON NANOPARTICLES
AS A NUTRITIVE SUPPORT FOR SOME
FRUIT TREES TRANSPLANTS**

By

MOHAMED KHALED ABOU EL-NASR ABBAS

B. Sc. Agric. Sc. (Plant Production), Ain Shams University, 2012

A thesis submitted in partial fulfillment
of
the requirements for the degree of

MASTER OF SCIENCE

in

**Agricultural Science
(Pomology)**

**Department of Horticulture
Faculty of Agriculture
Ain Shams University**

2015

A MODEL FOR USING IRON NANOPARTICLES AS A NUTRITIVE SUPPORT FOR SOME FRUIT TREES TRANSPLANTS

By

MOHAMED KHALED ABOU EL-NASR ABBAS

B. Sc. Agric. Sc. (Plant Production), Ain Shams University, 2012

Under the supervision of:

Dr. Hussein Mahmoud El-Hennawy

Prof. Emeritus of Pomology, Department of Horticulture, Faculty of
Agriculture, Ain Shams University (Principal Supervisor)

Dr. Ashraf Mahmoud Hassan El-Kereamy

Associate Prof. of Pomology, Department of Horticulture, Faculty of
Agriculture, Ain Shams University

Dr. Taher Ahmed Salah El-Din

Senior Researcher of Nanotechnology, Nanotechnology & Advanced
Materials Central Lab, Agricultural Research center.

نموذج لإستخدام جزيئات الحديد النانومترية للدعم الغذائي لبعض شتلات أشجار الفاكهة

رسالة مقدمة من

محمد خالد أبوالنصر عباس

بكالوريوس علوم زراعية (إنتاج نباتي)، جامعة عين شمس، 2012

للحصول على
درجة الماجستير في العلوم الزراعية
(فاكهة)

قسم البساتين

كلية الزراعة

جامعة عين شمس

2015

رسالة ماجستير

اسم الطالب : محمد خالد أبو النصر عباس
عنوان الرسالة : نموذج لإستخدام جزيئات الحديد النانومترية للدعم
الغذائي لبعض شتلات أشجار الفاكهة
اسم الدرجة : ماجستير في العلوم الزراعية (فاكهة)

لجنة الإشراف :

د. حسين محمود الحناوى
أستاذ الفاكهة المتفرغ، قسم البساتين ، كلية الزراعة، جامعة عين شمس (المشرف الرئيسى)

د. أشرف محمود حسن الكرى
أستاذ مساعد الفاكهة ، قسم الإنتاج البساتين ، كلية الزراعة، جامعة عين شمس

د. طاهر أحمد صلاح الدين
باحث أول النانوتكنولوجيا ، المعمل المركزى للنانوتكنولوجيا والمواد المتقدمة ، مركز
البحوث الزراعية

تاريخ التسجيل : 2013 / 2 / 11

الدراسات العليا

أجيزت الرسالة بتاريخ

ختم الإجازة

2015 / 10 / 17

موافقة مجلس الجامعة

موافقة مجلس الكلية

2015 / /

2015 / /

ACKNOWLEDGEMENT

Firstly and foremost praise and gratitude ALLAH Almighty.

I would like to express my deep appreciation and gratitude for my supervisor, **Prof. Dr. Hussein Mahmoud El-Hennawy**, Professor Emeritus of Pomology, Department of Horticulture, Faculty of Agriculture, Ain Shams University (Principal Supervisor) for preparation of the manuscript, patience, close supervision, suggesting the problem, continued guidance, encouragement throughout the research study and revision of the manuscript.

I would like to express my deep appreciation to **Prof. Dr. Ahmed Abou El-Yazied**, Professor of vegetable crops, Department of Horticulture, Faculty of Agriculture, Ain Shams University for his suggesting and revision of the manuscript.

I would like to express my sincere gratitude and thanks to **Dr. Taher Ahmed Salah El-Din**, Director of Nanotechnology & Advanced Materials Central Lab, Agricultural Research center (ARC) for his close supervision, continuous help and encouragement throughout the practical part of nanotechnology.

Sincere appreciation expressed to **Dr. Ashraf Mahmoud Hassan El-Kereamy**, Assistant Professor of Pomology, Department of Horticulture, Faculty of Agriculture, Ain Shams University for his supervision, valuable advice, continuous help and encouragement throughout the practical part of this work.

I would like to express my sincere gratitude to team work of Nanotechnology & Advanced Materials Central Lab **Dr. Khaled Farroh and his colleagues** for great help and cooperation during the experimental work.

Finally, I would express my utmost sincere appreciation to all my colleagues, my family and **my fiancée** for their moral support, which made this work comes to reality.

ABSTRACT

Mohamed Khaled Abou El-Nasr Abbas: A Model for Using Iron Nanoparticles as a Nutritive Support for Some Fruit Trees Transplants. Unpublished M.Sc Thesis, Department of Horticulture, Faculty of Agriculture, Ain Shams University, 2015.

This study was performed in the lath house of the Experimental Farm, Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Egypt in the two successive seasons of 2013 and 2014 to determine the effect of foliar spray with magnetite nanoparticles (MNPs) as nutrient supplement on some growth parameters and chemical components of orange saplings (*Citrus sinensis* L) Valencia cultivar., grape saplings (*Vitis vinifera* L) Flame seedless cultivar., and pear saplings (*Pyrus serotina* L. X *Pyrus communis* L.) Le-Conte cultivar.

The major parameters of vegetative growth, leaf content of N % and Fe (ppm), leaf pigments content, leaf content of total carbohydrates % and total amino acids.

The protocol used in the preparation of nanoscale iron particles after the characterization and identification of nanoparticles, we concluded that iron is present in the form of Magnetite nanoparticles (Fe_3O_4).

Results showed that application of MNPs gave the highest significant values of plant height, leaf area per sapling and fresh & dry weight of sapling in both seasons. Additionally, plant chemicals showed a tremendous increase for the values of leaf pigments content compared with foliar spray with iron chelated and control treatment. Also MNPs was the most effective treatment in increasing the tested chlorophyll-a and chlorophyll-b, total chlorophyll and carotenoids content in both studied seasons. Application of MNPs gave the maximum increase for leaf nitrogen and iron content in both seasons. Also increased leaf total carbohydrates and amino acids content of saplings comparing with other treatments in the two studied seasons.

Application of MNPs at 125 ppm and 250 ppm gave the best effect on parameter of orange, grape and pear saplings.

MNPs proved to have unique physicochemical properties and superparamagnetism that boosted over all plant metabolism that affected by biomass and bio-chemical properties.

Key words:

Magnetite nanoparticles, MNPs, nutrient, supplement, sapling, pear, orange, grape.

CONTENTS

	page
LIST OF TABLES	IV
LIST OF FIGURES	VI
LIST OF ABBREVIATIONS	IX
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	
2.1. Effect of nanoparticles on growth parameters	4
2.2. Effect of nanoparticles on leaf pigments content	6
2.3. Effect of nanoparticles on chemical components	7
3. MATERIALS AND METHODS	
3.1. Plant material	10
3.2. Preparation protocol of iron nano-particles	10
3.3. Vegetative parameters	11
3.3.1. Plants height (cm)	11
3.3.2. Stem diameter (mm)	11
3.3.3. Number of leaves	11
3.3.4. Leaf area (cm ²)	12
3.3.5. Fresh weight and dry weight	12
3.3.5.1 Fresh weight (g/plant)	12
3.3.5.2 Dry weight (g/plant)	12
3.4. Chemical analysis	12
3.4.1. Leaf pigments content	12
3.4.2. Total amino acid and total carbohydrates	13
3.4.2.1 Total amino acid (g/100g)	13
3.4.2.2 Total carbohydrates (%)	13
3.4.3 Nitrogen and iron contents	13
3.4.3.1 Nitrogen (%)	13
3.4.3.2 Iron (ppm)	14

3.5. Laboratory measurements for identification of nano scale iron particles	14
3.5.1 Transmission electron microscope (TEM)	14
3.5.2 X-Ray diffraction (XRD)	15
3.5.3 Vibrating Sample Magnetometer (VSM)	16
3.5.4 Zeta sizer	16
3.6. Statistical Analysis	17
4. RESULTS AND DISCUSSION	
4.1. Characterization of synthesized magnetite nanoparticles	18
4.1.1. The shape morphology	18
4.1.2. The chemical composition	18
4.1.3. The magnetic property	19
4.1.4. Particle size	20
4.2. Effect of magnetite nanoparticles on vegetative Parameter	22
4.2.1. Plant Height (cm)	22
4.2.2. Number of leaves	30
4.2.3. Stem diameter (mm)	38
4.2.4. Leaf Area (cm ²)	45
4.2.5. Fresh and Dry Weight	53
4.2.5.1. Fresh weight	53
4.2.5.1. Dry weight	53
4.3. Effect of magnetite nanoparticles on some chemical components	58
4.3.1. Leaf pigments content	58
4.3.1.1. Chlorophyll (a) content	58
4.3.1.2. Chlorophyll (b) content	58
4.3.1.3. Total chlorophyll content	59
4.3.1.4. Carotenoids	60
4.3.2. Total carbohydrates percent and total amino acids.	65
4.3.2.1. Total carbohydrates percent	65
4.3.2.2. Total amino acids percent	65

4.3.3. Nitrogen percent and total iron content	66
4.3.3.1. Nitrogen percent	66
4.3.3.2. Total iron content	67
5. SUMMARY AND CONCLUSION	78
6. REFERENCES	81
ARABIC SUMMARY	

LIST OF TABLES

No.		Page
1	Effect of foliar application of MNPs and chelated iron on some vegetative parameters of orange saplings Valencia cultivar during the two seasons (2013 and 2014).	55
2	Effect of foliar application of MNPs and chelated iron on some vegetative parameters of pear saplings Le-Conte cultivar during the two seasons (2013 and 2014).	56
3	Effect of foliar application of MNPs and chelated iron on some vegetative parameters of grape saplings Flame seedless cultivar during the two seasons (2013 and 2014).	57
4	Effect of foliar application of MNPs and chelated iron on leaf pigments content of orange saplings Valencia cultivar during the two seasons (2013 and 2014).	62
5	Effect of foliar application of MNPs and chelated iron on leaf pigments content of pear saplings Le-Conte during the two seasons (2013 and 2014).	63
6	Effect of foliar application of MNPs and chelated iron on leaf pigments content of grape saplings Flame seedless cultivar during the two seasons (2013 and 2014).	64
7	Effect of foliar application of MNPs and chelated iron on total carbohydrates (%), total amino acid (g/100g), iron content (ppm) and nitrogen (%) of orange saplings Valencia cultivar during the two seasons (2013 and 2014).	69
8	Effect of foliar application of MNPs and chelated iron on total carbohydrates (%), total amino acid (g/100g), iron content (ppm) and nitrogen (%) of pear saplings	

	Le-Conte cultivar during the two seasons 2013 and 2014.	70
9	Effect of foliar application of MNPs and chelated iron on total carbohydrates (%), total amino acid (g/100g), iron content (ppm) and nitrogen (%) of pear saplings Le-Conte cultivar during the two seasons 2013 and 2014.	71
10	Correlation coefficients for effect of MNPs on studied chemicals properties in orange saplings Valencia cultivar	76
11	Correlation coefficients for effect of MNPs on studied chemicals properties in pear saplings Le-Conte cultivar	76
12	Correlation coefficients for effect of MNPs on studied chemicals properties in grape saplings Flame seedless cultivar	77

LIST OF FIGURES

No.		Page
1.	HR-TEM image of the prepared Magnetite Nanoparticles capped with oxidation state of ascorbic acid shows that particles have spherical shape.	18
2.	Graph represents the XRD pattern of synthesized nanoparticles shows the formation of Fe_3O_4 capped with oxidation state of Ascorbic acid based on the comparison of their XRD patterns with the standard pattern of Fe_3O_4 .	19
3.	Hysteresis loop obtained from VSM measurements of synthesized MNPs capped with state of Ascorbic acid	20
4.	Graph showing particle size distribution by number for synthesized nanoparticles that was obtained by particle size analyzer.	21
5.	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on plant height of orange saplings Valencia cultivar during the two seasons (2013 and 2014)	24
6.	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on plant height growth rate of orange saplings Valencia cultivar during the seasons (a) 2013 and (b) 2014	25
7.	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on plant height of pear saplings Le-Conte cultivar during the two seasons (2013 and 2014)	26

8. Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on plant height growth rate of pear saplings Le-Conte cultivar during the seasons (a) 2013 and (b) 2014 27
9. Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on plant height of grape saplings Flame seedless cultivar during the two seasons (2013 and 2014) 28
10. Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on plant height growth rate of grape saplings Flame seedless cultivar during the seasons (a) 2013 and (b) 2014 29
11. Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on leaf number of orange saplings Valencia cultivar during the two seasons (2013 and 2014). 32
12. Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on Number of leaves growth rate of orange saplings Valencia cultivar during the seasons (a) 2013 and (b) 2014 33
13. Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on leaf number of pear saplings Le-Conte cultivar during the two seasons (2013 and 2014). 34

14	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on Number of leaves growth rate of Pear saplings Le-Conte cultivar during the seasons (a) 2013 and (b) 2014	35
15	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on leaf number of grape saplings Flame seedless cultivar during the two seasons (2013 and 2014)	36
16	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on Number of leaves growth rate of grape saplings Flame seedless cultivar during the seasons (a) 2013 and (b) 2014	37
17	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on stem diameter of orange saplings Valencia cultivar during the two seasons (2013 and 2014)	39
18	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on stem diameter growth rate of orange saplings Valencia cultivar during the two seasons 2013 (a) and 2014 (b)	40
19	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on stem diameter of pear saplings Le-Conte cultivar during the two seasons (2013 and 2014)	41
20	Effect of foliar application of magnetite nanoparticles (MNPs) and chelated iron on stem diameter growth rate of pear saplings Le-Conte cultivar during the two seasons 2013(a) and 2014(b)	42