

**EFFECT OF NANOFERTILIZERS ON CUCUMBER
PLANT GROWTH, FRUIT, YIELD
AND IT'S QUALITY**

By

AMANY FAROUK RADWAN ABASS

B.Sc. Agric. Sci (Vegetable Crops), Fac. Agric., Cairo Univ., 2013

THESIS

**Submitted in Partial Fulfillment of the
Requirements for the Degree of**

MASTER OF SCIENCE

In

**Agricultural Sciences
(Vegetable Crops)**

**Department of Vegetable Crops
Faculty of Agriculture
Cairo University
Egypt**

Formate Reviewer

2019

Vice Dean of Graduate Studies

APPROVAL SHEET

**EFFECT OF NANOFERTILIZERS ON CUCUMBER
PLANT GROWTH, FRUIT, YIELD
AND IT'S QUALITY**

**M. Sc. Thesis
In
Agric. Sci. (Vegetable Crops)**

By

AMANY FAROUK RADWAN ABASS
B.Sc. Agric. Sci (Vegetable Crops), Fac. Agric., Cairo Univ., 2013

APPROVAL COMMITTEE

Dr. FARHA HOSNY HASSAN.....
Senior Researcher of Vegetable Pests, Medical and Aromatic plants Agric.
Res. Center

Dr. SAID ABDALLA SHEHATA.....
Professor of Vegetable Crops, Fac. Agric., Cairo University

Dr. MOHAMED MOHAMED SHAHEIN.....
Professor of Vegetable Crops, Fac. Agric., Cairo University

Dr. MERGHANY MOHAMED MERGHANY.....
Professor of Vegetable Crops, Fac. Agric., Cairo University

Date: 7/ 9 / 2019

SUPERVISION SHEET

**EFFECT OF NANOFERTILIZERS ON CUCUMBER
PLANT GROWTH, FRUIT, YIELD
AND ITS QUALITY**

M. Sc. Thesis

In

Agric. Sci. (Vegetable Crops)

By

AMANY FAROUK RADWAN ABASS

B.Sc. Agric. Sci (Vegetable Crops), Fac. Agric., Cairo Univ., 2013

SUPERVISION COMMITTEE

Dr. MERGHANY MOHAMED MERGHANY

Professor of Vegetable Crops, Fac. Agric., Cairo University

Dr. MOHAMED MOHAMED SHAHEIN

Professor of Vegetable Crops, Fac. Agric., Cairo University

Dr. MAHMOUD ASHOUR ABDELSAMAD

Lecturer, National Institute of Laser Enhanced Science, Cairo University

Name of Candidate: Amany Farouk Radwan **Degree:** M.Sc.

Title of Thesis: Effect of nanofertilizers on cucumber plant growth, fruit yield and its quality

Supervisors: Dr. Merghany Mohamed Merghany
Dr. Mohamed Mohamed Shahein
Dr. Mahmoud Ashour Abdel Samad

Department: Vegetable Crops

Approval date: 7/9/2019

ABSTRACT

Using of mineral fertilizers has resulted in many serious environmental problems. Therefore, products obtained from different sources can be used. Nano fertilizers recently has been used in agriculture. This experiment was carried out in plastic green house, in the farm of faculty of Agriculture, Cairo University, Giza, Egypt during winter seasons of 2017-2018 and 2018-2019 to determine the effects of nanofertilizer on cucumber growth and fruit yield. Different concentrations (3, 4.5, 6 and 9 ml)/ plant of liquid nano NPK were used . The mineral fertilizer was used as control. Nanofertilizers has been added 50 additives but mineral fertilizer were added 6 additives. The results showed that the nanofertilizer treatments significantly improved the growth and yield of cucumber compared with control treatment. All treatments of nanofertilizer lead to increase plant height, number of leaves / plant, chlorophyll content, yield and NPK % in leaves and fruits. The treatment of 6 ml NPK increased the yield by 4.84% and 53.42% in the first and second seasons, respectively. When cold storage experiment was done, treatment of 6 ml NPK achieved the lowest weight loss % and the highest value of general appearance at the end of storage periods (21 days at 5 ° C compared to all other treatments. The treatment of Control NPK recorded the highest value of firmness, TSS and decay % after 21 days of storage at 5 ° C. It can be concluded that nanofertilizer improved the plant growth, yield and fruit quality of cucumber and it can be used as an alternative to mineral fertilizers.

Key words: *Cucumis sativus*, nano NPK, growth, yield, quality and cold storage

DEDICATION

I dedicate this dissertation to my family. Special deep appreciation, feelings and love to my parents, my siblings, my daughter "Yomna" and my husband "Mahmoud Abdel Aziem " for their prayers, love, concern and support all time. Their presence and support always help and courage me to complete this work successfully.

To my dear and wonderful friends for their constant support, and bringing smiles in tough times.

Special deep appreciation and feelings to my sister "Eman Farouk" for her caring and support which always keep me up.

ACKNOWLEDGEMENT

In the name of Allah most gracious, most merciful, all praise is to Allah, the lord of the universe, without whose bounty I would not have completed this work.

I would like to express my profound gratitude and sincere appreciation to Dr. Merghany Mohamed Merghany, Professor of Vegetable Crops, Fac. Agric., Cairo University for his kind supervision, valuable guidance, generously given useful suggestion, indispensable help, ideas, continuous support throughout the achievement of this work during vital years of my life and revision the manuscript of this thesis.

Great thanks also are extended to Dr. Mohamed Mohamed Shahain, Professor of Vegetable Crops, Fac. Agric., Cairo University for his supervision, advising at all stages of my thesis.

Special thanks to Dr. Mahmoud Ashour Abdelsamad, Lecturer, National Institute of Laser Enhanced Science, Cairo University, for his supervision, advising at all stages of my thesis.

I wish to express my deepest sincere appreciation to Dr. Karima Farouk Abdelgawad, Associated Professor of Vegetable Crops, Fac. Agric., Cairo University for her valuable advices, help, kind support during this work. I wish to express my deepest sincere appreciation to Dr. Oaima Darwish Saleh lecturer of Vegetable Crops, Fac. Agric., Cairo University for help and kind support during this work. Great thanks also are to Dr. Mahmoud Mahamoud Abdel Wahab, Associated Professor of plant Physiology, Fac. Agric., Cairo University for his supervision, advising at all stages of my thesis.

Grateful appreciation is also extended to all staff members of Vegetable crops Department, Faculty of Agriculture, Cairo University.

CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	5
1. Effect of nanofertilizer	5
a. Vegetative growth.....	5
b. Yield and its components.....	10
c. Fruit quality.....	13
d. Chemical contents.....	14
2. Effect of mineral fertilizer	14
a. Vegetative growth.....	14
b. Yield and its component.....	16
c. Fruit quality	18
d. Chemical contents	19
MATERIALS AND METHODS	21
RESULTS AND DISCUSSION	29
1- Vegetative growth	29
2. Fruit and plant dry matter	35
3. Leaves pigments content	37
4. Yield component.....	41
5. Fruits quality.....	44
6. Leaves NPK content.....	46
7. Fruits NPK content	49
8. Cold storage experiment	52
SUMMARY	61
CONCLUSION	69
REFERENCES	71
ARABIC SUMMARY	

LIST OF TABLES

No.	Title	Page
1	Some physical and chemical properties of experimental soil	22
2	Effect of NPK nanofertilizers on growth parameters of cucumber plants, after 40 days of transplanting date during 2017/2018 and 2018/2019 seasons.....	29
3	Effect of NPK nano fertilizers on growth parameters of cucumber plants, after 60 days of transplanting date during 2017/2018 and 2018/2019 seasons.....	32
4	Effect of nanofertilizers on fruit and plant dry mater (%) during 2017/2018 and 2018/2019 seasons.....	35
5	Effect of NPK nanofertilizers on the chlorophyll and carotnoids contents (mg / g) of cucumber leaves during 2017/2018 and 2018/2019 seasons.....	38
6	Effect of nanofertilizers on yield of cucumber plants, during 2017/2018 and 2018/2019 seasons.....	41
7	EEffect of nanofertilizers on fruits TSS and firmness of cucumber during 2017/2018 and 2018/2019 seasons.....	45
8	Effect of nanofertilizers on leaves NPK contant (%) in dry mater of cucumber plants during 2017/2018 and 2018/2019 seasons.....	47
9	Effect of nanofertilizers on fruits NPK concentrations in dry mater of cucumber plants during 2017/2018 and 2018/2019 seasons.....	50
10	Effect of the interaction between treatments and storage periods on weight loss (%).....	52
11	Effect of the interaction between treatments and storage periods on fruits genral appearance.....	53
12	Effect of the interaction between treatments and storage periods on fruits firmness.....	55
13	Effect of the interaction between treatments and storage periods on TSS.....	56
14	Effect of the interaction between treatments and storage periods on decay.....	58

LIST OF FIGURES

No.	Title	Page
1	TEM Images of NPK nano fertilizer size a) Nitrogen, b) Phosphorus and c) Potassium.....	27
2	Plant height (cm) of cucumber plant as affected by nanofertilizer after 40 days of transplanting date during 2017/2018 and 2018/2019 seasons.....	30
3	Number of leaves / plant of cucumber as affected by nanofertilizer after 40 days of transplanting date during 2017/2018 and 2018/2019 seasons.....	31
4	Leaf area (cm ²) of cucumber plant as affected by nanofertilizer after 40 days of transplanting date during 2017/2018 and 2018/2019 seasons.....	31
5	Plant height (cm) of cucumber plant as affected by nanofertilizer after 60 days of transplanting date during 2017/2018 and 2018/2019 seasons.....	33
6	Number of leaves / plant of cucumber plant as affected by nanofertilizer after 60 days of transplanting date during 2017/2018 and 2018/2019 seasons.....	33
7	Fruit dry mater (%) as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	36
8	Dry mater / plant (%) of cucumber as affected by nanofertilizer during 2017/2018 and 2018/2019 season.....	36
9	Chlorophyll a (mg/g) of cucumber leaves as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	39
10	Chlorophyll b (mg/g) of cucumber leaves as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	39
11	Total chlorophyll of cucumber leaves as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	40
12	Total carotenoids (mg/g) of cucumber leaves as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	40
13	Total yield / plant of cucumber as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons...	42

LIST OF FIGURES (continued)

No.	Title	Page
14	Early yield / plant (g) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	43
15	Yield increasment (%) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	44
16	Fruit TSS of cucumber as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	45
17	Fruit firmness of cucumber as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	46
18	Leaves N content (%) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons...	47
19	Leaves P content (%) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons....	48
20	Leaves K content (%) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons....	48
21	Fruit N content (%) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	50
22	Fruit P content (%) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons.....	51
23	Fruit K content (%) of cucumber plant as affected by nanofertilizer during 2017/2018 and 2018/2019 seasons....	51
24	Effect of storage periods on weight loss %.....	52
25	Effect of the treatments on weight loss %.....	52
26	Effect of storage periods on fruits general appearance.....	54
27	Effect of the treatments on fruits general appearance.....	54
28	Effect of storage periods on fruits firmness.....	55
29	Effect of nano fertilizer on fruits firmness.....	56
30	Effect of storage periods on fruits TSS (%)......	57
31	Effect of the treatments on fruits TSS (%)......	57
32	Effect of storage periods on fruits decay (%)......	58
33	Effect of the treatments on fruits decay (%)......	59

INTRODUCTION

Cucumber (*Cucumis sativus L.*) is one of the most important vegetable crops grown broadly throughout the world (Soleimani et al., 2009). It is one of the most nutritive vegetables rich in vitamin A, C and E and minerals such as calcium, potassium, silica, phosphorus, iron, magnesium and it is rich in beta-carotene which is important for ensuring vitamin A adequacy in the human diet (Sumathi et al., 2008 and Trumbo et al., 2001). It is a tropical and subtropical crop belonging to family cucurbitaceae. The cultivated area of cucumber in Egypt was 95328.151 feddan in 2017, while the production was 488723 tones (FAO 2019). Chemical fertilizer used in crop fertilization contains a small number of minerals that dissolve rapidly in wet soils and given the plants large doses of minerals (Vernon, 1999). The plants during growth stages need to chemical compounds to enhance its growth. These chemical compounds are named mineral fertilizers. Artificial fertilizers are inorganic fertilizers prepared in ideal concentrations of macro and micro nutrients. Nitrogen is an important nutrient element which is essential for plant growth. The most widely used water soluble source of nitrogen is Urea (46 % N). The nitrogen concentration of soil gets decreased because of leaching. Consequently, nitrogen utilization efficiency (NUE) is low. Urea modified hydroxyapatite particles have been used to agriculture; because of itll s higher NUE and slow release of the nitrogen to the soil and lead to maximize NUE by plants and minimize the adverse effects to the environment (Subbaiya et al.,2012). Phosphorus has an important role in several physiological processes in the plant, such as energy

storage, photosynthesis transfer, respiration, cell enlargement and cell division. Also, Phosphorus is an important structural component of many biochemical's such as nucleic acids (DNA, RNA) co-enzymes, nucleotides, sugar phosphate and phospholipids. It stimulates root growth, fruit setting blooming and seed formation (Memon, 1996). Potassium is considered essential in photosynthesis, nitrogen metabolism, sugar translocation, enzyme activation, water relation, stomatal opening and growth of meristematic tissues, root booster, stalk strengthener, breathing regulator, protein builder and retard the diseases, but it is not effective without its co-efficient such as N and P (Chandra, 1989). The recent use of chemical fertilizers has resulted in many serious environmental problems such as accumulation of heavy metals in soil and plant system (Abdel Wahab et al., 2017). Therefor, It is necessary to use modern ideas for fertilizing the vegetable crops to increase food production. Nanotechnology has been defined as relating to materials, systems and processes which operate at a scale of 100 nanometers (nm) or less (Mousavi and Rezai 2011, Srilatha 2011 and Ditta 2012). The improvement in nanotechnology have permit its application to agriculture and the food industry, and particularly in agriculture are becoming popular (Ruttkay et al., 2017). On the other hand, its utility is still bounded because of shortage of information about the toxicity and its effect on the environmental (Narayanan et al., 2012; Ruttkay et al., 2017), and also the little interest of uses of nanotechnology in plant sciences compared to nanomedicine and nano pharmacology (Wang. et al., 2016). Nanotechnology could play key role in rising global food production, food safety and security. Also, it

enhancing the efficiency and sustainability of farming practices (Servin et al., 2015).

Nanotechnology used in all stages of the production of agricultural products such as processing, packaging, transport and storage. It is used in the detection of diseases and control it. One of the most important uses of nanotechnology is nanofertilizer, which improves the ability of plants to absorb nutrients (Mousavi and Rezai 2011, Srilatha 2011 and Ditta 2012). The present research was aimed to study the effect of liquid nano NPK on cucumber growth, yield and quality, reducing the recommended dose of chemical fertilizer which aims to preserve the environment.

REVIEW OF LITERATURE

1. Effect of fertilizer

a. Vegetative growth

Zheng et al. (2005) The effects of nano-TiO₂ (rutile) and non-nano-TiO₂ on the germination and growth of naturally aged spinach seeds were studied by measuring the germination rate and the germination and vigor indexes. An increase of these factors was observed at 0.25-4% nano-TiO₂ treatment. During the growth stage, the plant dry weight was increased, as was the chlorophyll formation, the ribulosebiphosphate carboxylase/oxygenase activity, and the photosynthetic rate. The best results were found at 2.5% nano-TiO₂. The effects of non-nano-TiO₂ are not significant. It is shown that the physiological effects are related to the nanometer-size particles, but the mechanism by which nano-TiO₂ improves the growth of spinach seeds still needs further study.

Yang et al. (2006) The effects of nano-anatase TiO₂ on the nitrogen metabolism of growing spinach were studied by treating them with nano-anatase TiO₂. The results showed that, nano-anatase TiO₂ treatment could obviously increase the activities of nitrate reductase, glutamate dehydrogenase, glutamine synthase, and glutamic-pyruvic transaminase during the growing stage. Nano-anatase TiO₂ treatment could also promote spinach to absorb nitrate, accelerate, inorganic nitrogen (such as NO₃^{-N} and NH₄^{±N}) to be translated into organic nitrogen (such as protein and chlorophyll), and enhance the fresh weight and dry weights.