

**EFFECT OF SOME NANO-CHEMICAL COMPOUNDS
ON SALINITY TOLERANCE FOR GREEN
BEAN PLANTS**

By

RABIE MOHAMED GOMAA EID

B. Sci. Agric. (Horticulture - Pomology), Cairo University, 2004

A Thesis Submitted in Partial Fulfillment

Of

The Requirements for the Degree of

MASTER OF SCIENCE

in

Agricultural Sciences

(Agriculture in Desert and Salt Affected Areas)

Arid Land Agricultural Graduated Studies and Research Institute

Faculty of Agriculture

Ain Shams University

2017

Approval Sheet

**EFFECT OF SOME NANO-CHEMICAL COMPOUNDS
ON SALINITY TOLERANCE FOR GREEN
BEAN PLANTS**

By

RABIE MOHAMED GOMAA EID

B. Sci. Agric. (Horticulture - Pomology), Cairo University, 2004

This thesis for M.Sc. degree has been approved by:

Dr. Shamel Ahmed Shanan
Prof. Emeritus of Vegetable Crops, Faculty of Agriculture, Al-Azhar
University.

Dr. Ayman Farid Abou-Hadid
Prof. Emeritus of Vegetable Crops, Faculty of Agriculture, Ain Shams
University.

Dr. Usama Ahmed Ali El-Behairy
Prof. of Vegetable Crops, Faculty of Agriculture, Ain Shams University.

Dr. Mohamed Zaky El-Shinawy
Prof. of Vegetable Crops, Faculty of Agriculture, Ain Shams University.

Date of Examination: 27/4/ 2017

EFFECT OF SOME NANO-CHEMICAL COMPOUNDS ON SALINITY TOLERANCE FOR GREEN BEAN PLANTS

By

RABIE MOHAMED GOMAA EID

B. Sci. Agric. (Horticulture - Pomology), Cairo University, 2004

Under the supervision of:

Dr. Mohamed Zaky El - Shinawy

Prof. of Vegetable Crops, Department of Horticulture, Faculty of
Agriculture, Ain Shams University (Principal Supervisor).

Dr. Usama Ahmed El-Behairy

Prof. of Vegetable Crops, Department of Horticulture, Faculty of
Agriculture, Ain Shams University.

Dr. Alaa El – Din Salah Tantawy

Researcher Associate Prof. of Vegetable Crops, Department of
Vegetable Researches, National Research Center.

ACKNOWLEDGEMENT

Praise and thanks to **Allah**, who guided and helped us to achieve this work.

The writer wishes to express his gratitude and sincere thanks to **Prof. Dr. Mohamed Zaky El-Shinawy**, Professor of Vegetable Crops, Horticulture Department, Faculty of Agriculture, Ain Shams University, for his supervision, kind help, follow up and constructive ideas and advice.

Deepest and sincere gratitude and appreciation to **Prof. Dr. Usama Ahmed Ali El-Behairy** Professor of Vegetable Crops, Horticulture Department, Faculty of Agriculture, Ain Shams University, for his kind supervision, valuable assistance, moral and faithful attitude during the preparation of this manuscript.

The events wishes to express has deepest grateful thanks and sincere to **Dr. Alaa El -Din Salah Tantawy**, Associate Prof. of Vegetable Crops, Department of Vegetable Research, National Research Center, for his supervision, valuable assistance, moral and faithful attitude during the preparation of this manuscript.

My grateful thanks also to **all staff members of Arid and Agricultural Research and Service Center**, Faculty of Agriculture, Ain Shams University, for their kind help and facilities granted during this work.

My heart full of thanks and sincere appreciation to **my family (my mother, brother and my sisters)**, for their helpful support and encouragement all over my life.

Finally, sincere gratitude is expressed to **my wife** for her encouragement, support and patient through all the hard times.

ABSTRACT

Rabie Mohamed Gomaa Eid: Effect of Some Nano-Chemical Compounds On Salinity Tolerance For Green Bean Plants. Arid Land Agricultural Graduated Studies and Research Institute, Faculty of Agriculture, Ain Shams University, 2017. Unpublished M.Sc. Thesis.

Two pot experiments were carried out during the two successive autumn seasons of 2013 and 2014 in a private farm in Abou Ghalib region, Giza governorate to investigate the effects of using two different nano materials namely nano calcium and nano silicon to alleviate the effect of different salinity levels on the growth and yield of green bean plants (*Phaseolus vulgaris*, L.) cv. Pulista under sand soil conditions. Seeds of green bean were sowing in pots which contained sandy soil, and irrigated with saline water with EC of 500, 1000 and 1500 ppm. Nano silicon and calcium were supplied at concentrations of 1 cm³/l and 2 cm³/l for nano silicon and 0.5 g / l and 1 g / l for nano calcium respectively. Application took place at 3, 5, 7 and 9 weeks after cultivated. Data showed that all plant growth aspects such as plant height, plant fresh and dry weights, leaf area and number of leaves, were decreased under salinity level alone, but which improved under all nano calcium and nano silicon treatments in presence water saline irrigation compared to none treated plants (control). In the same trend nitrogen, phosphorus, potassium and calcium percentages in green bean leaves were declined under high salinity level (1000 and 1500 ppm) but, sodium, proline and fiber were increased under high salinity level. Yield parameters such as total pod yield and marketable pod yield improved under all nano calcium and nano silicon treatments. Among nano silicon and calcium treatments, concentration of 2 cm³/l and 1 g / l respectively recorded the highest significant effect in mitigating salinity negative effects. It could be concluded that nano silicon and calcium was more effective and efficient in mitigating salinity stress on green bean plants.

Keywords: Green bean, Salinity, Nano Silicon, Nano calcium, Total Chlorophyll, N, P, K, Total Yield.

CONTENTS

	Page
1. INTRODUCTION	1
2. REVIEW OF LITERATURE	3
2.1 Effect of saline water irrigation	3
2.1.1 Vegetative growth characteristics	3
2.1.1.1 Physical characteristics	3
2.1.1.1.1 Plant height	3
2.1.1.1.2 Fresh weight / plant	5
2.1.1.1.3 Dry weight / plant	6
2.1.1.1.4 Leaf area	8
2.1.1.1.5 Leaves number / plant	9
2.1.1.1.6 Total chlorophyll	10
2.1.1.2 Chemical characteristics	12
2.1.1.2.1 Nitrogen	12
2.1.1.2.2 Phosphorus	13
2.1.1.2.3 Potassium	14
2.1.1.2.4 Calcium	15
2.1.1.2.5 Sodium	16
2.1.1.2.6 Proline	17
2.1.1.2.7 Silicon percentage	18
2.1.2 Yield characteristics	18
2.1.2.1 Total pod yield	18
2.1.2.2 Marketable pod yield	20
2.1.2.3 Unmarketable pod yield	20
2.1.3 Pod characteristics	21
2.1.3.1 Physical characteristics	21

	Page
2.1.3.1.1 Pod length	21
2.1.3.1.2 Pod diameter	21
2.1.3.2 Chemical characteristics	21
2.1.3.2.1 Fiber percentage	21
2.2 Effect of Nano elements	22
2.2.1 Nano Calcium	22
2.2.1.1 Vegetative growth characteristics	22
2.2.1.1.1 Physical characteristics	22
2.2.1.1.1.1 Plant height	22
2.2.1.1.1.2 Fresh weight / plant	22
2.2.1.1.1.3 Dry weight / plant	23
2.2.1.1.1.4 Leaf area	23
2.2.1.1.1.5 Leaves number / plant	23
2.2.1.1.1.6 Total chlorophyll	23
2.2.1.1.2 Chemical characteristics	24
2.2.1.1.2.1 Nitrogen	24
2.2.1.1.2.2 Phosphorus	24
2.2.1.1.2.3 Potassium	24
2.2.1.1.2.4 Calcium	25
2.2.1.1.2.5 Sodium	25
2.2.1.1.2.6 Proline	25
2.2.1.1.2.7 Silicon	26
2.2.1.2 Yield characteristics	26
2.2.1.2.1 Total yield	26
2.2.1.2.2 Marketable yield	26
2.2.1.2.3 Unmarketable yield	26

III

	Page
2.2.1.3 Pod characteristics	27
2.2.1.3.1 Physical characteristics	27
2.2.1.3.1.1 Pod length	27
2.2.1.3.1.2 Pod diameter	27
2.2.1.3.2 Chemical characteristics	27
2.2.1.3.2.1 Fiber percentage	27
2.2.2 Nano Silicon	28
2.2.2.1 Vegetative growth characteristics	28
2.2.2.1.1 Physical characteristics	28
2.2.2.1.1.1 Plant height	28
2.2.2.1.1.2 Fresh weight / plant	28
2.2.2.1.1.3 Dry weight / plant	28
2.2.2.1.1.4 Leaf area	29
2.2.2.1.1.5 Leaves number / plant	29
2.2.2.1.2.6 Total chlorophyll	29
2.2.2.1.2 Chemical characteristics	30
2.2.2.1.2.1 Nitrogen	30
2.2.2.1.2.2 Phosphorus	30
2.2.2.1.2.3 Potassium	30
2.2.2.1.2.4 Calcium	31
2.2.2.1.2.5 Sodium	31
2.2.2.1.2.6 Proline	31
2.2.2.1.2.7 Silicon	32
2.2.2.2 Yield characteristics	32
2.2.2.2.1 Total yield	32
2.2.2.2.2 Marketable yield	32

	Page
2.2.2.2.3 Unmarketable yield	32
2.2.2.3 Pod characteristics	33
2.2.2.3.1 Physical characteristics	33
2.2.2.3.1.1 Pod length	33
2.2.2.3.1.2 Pod diameter	33
2.2.2.3.2 Chemical characteristics	33
2.2.2.3.2.1 Fiber percentage	33
3. MATERIALS AND METHODS	34
3.1. Experimental layout	34
3.2. Treatments	35
3.3. Recorded data	36
3.4 Experimental design	39
3.5 Statistical analysis	39
4. RESULT	40
4.1 Vegetative growth characteristics	40
4.1.1 Physical characteristics	40
4.1.1.1 Plant height	40
4.1.1.2 Fresh weight / plant	41
4.1.1.3 Dry weight / plant	42
4.1.1.4 Leaf area	44
4.1.1.5 Leaves number / plant	45
4.1.1.6 Total chlorophyll content	47
4.1.2 Chemical characteristics	49
4.1.2.1 Nitrogen	49
4.1.2.2 Phosphorus	50
4.1.2.3 Potassium	51

	Page
4.1.2.4 Calcium	53
4.1.2.5 Sodium	54
4.1.2.6 Proline	55
4.1.2.7 Silicon percentage	57
4.2 Yield characteristics	58
4.2.1 Total pod yield	58
4.2.2 Marketable pod yield	59
4.2.3 Unmarketable pod yield	60
4.3. Pod characteristics	62
4.3.1 Physical characteristics	62
4.3.1.1 Pod length	62
4.3.1.2 Pod diameter	63
4.3.2 Chemical characteristics	64
4.3.2.1 Nitrogen	64
4.3.2.2 Phosphorus	66
4.3.2.3 Potassium	67
4.3.2.4 Sodium	69
4.3.2.5 Fiber	70
5. DISCUSSION	77
6. SUMMARY AND CONCLUSION	84
7. REFERENCES	90
ARABIC SUMMARY	

LIST OF TABLES

	Page
Table (1) The physical and chemical analysis of the sand soil in 2013 and 2014 seasons.	34
Table (2) Effect of salinity levels, nano chemical and interaction on plant height, fresh weight and dry weight of green bean plants in 2013 and 2014 seasons.	43
Table (3) Effect of salinity levels, nano chemical and interaction on Leaf area, Leaves Number and total chlorophyll of green bean plants in 2013 and 2014 seasons.	48
Table (4) Effect of salinity levels, nano chemical and interaction on nitrogen, phosphors and potassium of green bean leaves in 2013 and 2014 seasons.	52
Table (5) Effect of salinity levels, nano chemical and interaction on calcium, sodium, proline and silicon of green bean leaves in 2013 and 2014 seasons.	56
Table (6) Effect of salinity levels, nano chemical and interaction on total yield, marketable yield and Unmarketable yield of green bean plants in 2013 and 2014 seasons.	61
Table (7) Effect of salinity levels, nano chemical and interaction on pod length, and pod diameter (mm) in green bean plants in 2013 and 2014 seasons.	65
Table (8) Effect of salinity levels, nano chemical and interaction on nitrogen, phosphorus and potassium in pods of green bean plants in 2013 and 2014 seasons.	68
Table (9) Effect of salinity levels, nano chemical and interaction on sodium and fibers in pods of green bean plants in 2013 and 2014 seasons.	71

LIST OF FIGURE

		Page
Fig. (1)	Effect of salinity levels on green bean plants	73
Fig. (2)	Effect of interaction between salinity level (500 ppm and nano calcium)	74
Fig. (3)	Effect of interaction between salinity level (500 ppm and nano silicon)	74
Fig. (4)	Effect of interaction between salinity level (1000 ppm and nano calcium)	75
Fig. (5)	Effect of interaction between salinity level (1000 ppm and nano silicon)	75
Fig. (6)	Effect of interaction between salinity level (1500 ppm and nano calcium)	76
Fig. (7)	Effect of interaction between salinity level (1500 ppm and nano silicon)	76

INTRODUCTION

The common bean is an annual legume cultured for its green pod and dry seed, both of which are eaten. In common with all other legumes it's a good source of protein (**Halterlein, 1983**). Green bean is an important crop in Egypt for local consumption as well as for exportation. This crop is growing in the open field in two main seasons i.e., spring and autumn. The total area of green beans was about 59687 feddans, which produced about 253110 tons, with an average of 4.241 tons / feddan (**FAO Statistics, 2014**).

Egypt has a significant comparative advantage in the production of horticultural commodities including green bean for export, based on its geographic position and agro-climatic conditions. It was reported that the Egyptian share in the Dutch market reached about 25% with Egypt being the main exporter of green beans to the Netherlands just ahead of Spain (24%) and Kenya (20%) (**HEIA, 2003**). The Egyptian annual growth in the production of green beans was estimated to represent half of the world's total growth (**Wijnands, 2004**). However, as most of the expansion of green bean cultivation is taken place in the new reclaimed lands, this expansion is constrained by some limiting factors such as salinity. Not only in the new land but also in the old valley where a considerable areas has become salt affected soils. According to **Gehad (2003)**, some 90 thousands hectares of Nile Valley and Delta region are salinity affected soil. The problem is aggregated more when over withdraw is carried out from underground water wells and/or inefficient drain system is installed in the cultivated soil. This leads either to crop failure or at least to a significant reduction in yield and quality. Many trails have been carried out in order to help the grower to overcome those negative effects and increase his alternatives in the growing patterns and quantity and quality of his production. Among those trails, modification of greenhouse climate (**Abdel-Mawgoud et al., 2004**); application of organic matter such as humate (**Abdel-Mawgoud et al., 2007**); application of specific nutrients such as amino acids or growth regulators

INTRODUCTION

(El-Abd *et al.*, 2005; Tantawy *et al.*, 2009; 2013) and minerals i.e calcium and silicon. The latter two nutrients have been reported to alleviate salinity stress and improve plant performance and production (Awada *et al.*, 1995; Haghighi *et al.*, 2012; Tantawy *et al.*, 2015). Nano-technology can present solution to increasing the value of agricultural products and environmental problems. Nano materials because of their tiny size show unique characteristics. They can change physic–chemical properties compared to their bulk materials, they have a great surface area than bulk materials. Because of these larger surface areas, their solubility and surface reactivity was higher (Castiglione and Cremonini 2009). By manufacturing the preparation ways of nano materials can change their characteristics, for example, the addition of nano particles in liquid changes their chemical, physiological and transport characteristics compared to their base fluids such as enhancement of thermal conductivity (Ashok and Raykar 2008). However, by introducing nanotechnology into agriculture, many of the agricultural inputs have become more effective and its application became more efficient. This is due to the fact that nano technology makes the particles smaller in size have higher active properties.

Therefore, this study is aiming at and investigating the effect of applying nano calcium and silicon separately in different concentrations on alleviating the negative effects of salinity on green bean plants.

REVIEW OF LITERATURE

The present review of literature has involved studies on the effect of I. saline water irrigation on the growth, yield and its quality of green bean plants. II. The effect of nano calcium and silicon on salinity tolerance in green bean plants and all reviewed under the following headings:

2.1 Effect of saline water irrigation

2.1.1 Vegetative growth characteristics

2.1.1.1 Physical characteristics

2.1.1.1.1 Plant height

One of the most important plant physical attributes which have been most easily and frequently measured was plant height. Most attempts on the estimation of plant height in some vegetable crops showed a continuous depression with the increase in salinity levels. Thus, **Ramadan and Ibrahim (2006)** concluded that there was significant and gradually decrease in green bean plant height by increasing salinity level from 1000 to 2000 ppm compared by the control (250 ppm). **Also, Gama et al. (2007a)** indicated that plant height of five cultivars of common bean (Bassbeer, Beladi, Giza 3, HRS 516 and RO21) decreased when plants irrigated by saline water at concentration of 50 and 100 mM NaCl compared by the control (0 mM NaCl). In the same trend **Stoeva and Kaymakanova (2008)** found that reduction in plant height under salinity conditions (50 and 100 mM NaCl) were obtained in bean plants cv. Lody in both concentrations. Also on bean plants **Taffouo et al. (2008)** noticed that when bean plants submitted to four levels of salt stress at the roots (0, 50, 100 and 200 mM of NaCl) stem height decreased by increasing salinity level compared by the control (0.0 mM NaCl). **Ndakidemi and Makoi (2009)** illustrated that when bean plants cvs (Lyamungo 90, Jesca, Flora de Mayo and CAB 19) irrigated by saline water at NaCl concentrations (2.5, 5.0, 10.0 mM) decreased plant height in all cultivars