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Improving Growth, Flowering, Fruiting and Resistance of Malformation of Mango Trees using Nano-Zinc

[1]Osama A. Zagzog and [2]Mohamed M. Gad

[1]Plant Prod. Dept., Fac. of Tech. and Deve., Zagazig Univ., Egypt.
[2]Hort. Dept., Fac. of Agric., Zagazig Univ., Egypt.

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ABSTRACT

This study was carried out during of 2015 and 2016 seasons to investigate the effect of some some foliar spray with nano-zinc concentrations i.e., spraying with only mineral oil 1.5% as (control) and 0.5 & 1 g/l nanu zinc before flowering at 15 February were applied to determine growth, flowering, fruiting, fruit quality and resistance of Zebda and Ewasy malformation of mango (*Mangifera indica* L.) cultivars. Ewasy CV displayed superior values panicle length, sex ratio, retention fruit at harvest, yield, leaf physical characteristics as well as pigments and mineral contents of leaf compared with Zebda CV. However, Zebda CV was high significantly content of leaf carotene as well as resistance of malformation percentage over Ewasy CV. Nano zinc treatments, especially 1 g/l one increased yield as number of fruit or weight / tree and resistance of malformation percentage as well as improving other studies attributes of fruit. Nano zinc treatments 0.5 g/l and 1 g/l gave significantly the highest values in fruit weight and yield /tree. In this respect the increase percentage were 41.45, 44.97 and 33.74, 57.36 respectively compared with untreated trees. From result of this research, it is recommending on under Belbeis district, Sharkia Governorate and the resembling conditions that spraying mango trees nano-zinc at 1g/l before flowering is desirable for improving yield and fruit quality as well as increase resistance of malformation.

Key words: Mango, nano zinc, malformation, fruit quality, fruit retention, Zebda, Ewasy

Introduction

Egyptian commercial mango orchards are concentrated in Ismailia, Sharkia, Giza, Faiyum and Behera governorates. This might be due to horizontal expansion of sandy soil reclamation and to the excellent agronomic practices privating nowadays in the commercial mango orchards. Meanwhile Egyptian mango growers were directed to increase their income from mango exportation. The total area of mango trees reached 240804 fed. (Ministry of Agriculture, 2014).

Mango trees are commonly infested with malformation in Egypt and several parts of the world as an important problem in mango industry. Unfortunately, the incidence of malformation phenomenon is exhibited throughout all the growth stages and causes severe weakness in vegetative growth and lead to continuous deterioration of mango crop in Egypt as well as in other parts of the world. It can be considering that mango malformation disease a dominant character in mango trees, as mentioned by Sharma and Majumder (1989). Mango malformation is considered to be the most fatal disorders of mango trees which not only negatively affect plant health but reduces yield. Floral malformation reduced the yield directly because malformed panicles seldom produce fruit rather presents an ugly look as they persist long on the tree (Singh and Dhillon 1993). Floral malformation is an intricate disorder directly linked with vegetative growth behavior of mangoes; annually causing about 37% losses (Khan and Khan 1960) which is reduced to 15% today and seriousness of malady vary from region to region and with the cultivar (Verma *et al.,* 1971).

Zinc is essential for many enzymes which are needed for nitrogen metabolism, energy transfer and protein synthesis. Zinc deficiency retards growth and yield of plants (Hafeez *et al*., 2013). As Zn is required for the synthesis of tryptophan which is a precursor of IAA, it also has an active role in the production of an essential growth hormone auxin (Alloway 2004 and Brennan 2005).

Corresponding Author: Osama A. Zagzog, Plant Prod. Dept., Fac. of Tech. and Deve., Zagazig Univ., Egypt.
E-mail: zagzog_1000@yahoo.com

The present investigation was outlined to explore alternative practices that may enhance growth, flowering, fruit quality and resistance of malformation on mango cultivars Ewasy (sensitive cultivar to malformation) and Zebda (resistant cultivar to malformation) Azzous et al., (1978) and Azza (2015) by using some foliar spray treatments with nano-zinc.

Materials and Methods

This investigation was carried out during the two consecutive seasons of 2015 and 2016 on mango trees (*Mangifera indica* L.) cultivars Zebda (resistant) and Ewasy (sensitive to malformation) grown in a private orchard at Belbeis district, Sharkia Governorate, Egypt to evaluate the effect of foliar spraying with nano-zinc on plant growth, fruit quality and resistance of floral malformation on mango cultivars Ewasy and Zebda. Orchard trees were 20 years old, grown at 4x6 meters apart, grafted on Succary rootstocks under drip irrigation system. All experimental units (trees) received similar in vigor and size agricultural practices whenever needed. The experiment included six treatments, which were the combinations between two cultivars Zebda and Ewasy and 3 levels of foliar spray with nano-zinc i.e., spraying with mineral oil 1.5% (control), as well as, nano-zinc 0.5 and 1 g/l before flowering at 15 February. The treatments were set up in a factorial experiment between cultivars (two levels) and nano-zinc (three levels 0, 0.5 and 1 g/l) in a complete block randomized design with three replicates for each treatment; each replicate was represented as one tree as follows:

1. Zebda trees sprayed with mineral oil 1.5%. (Control).
2. Zebda trees sprayed with nano zinc 0.5 g / l.
3. Zebda trees sprayed with nano zinc 1 g/l.
4. Ewasy trees sprayed with mineral oil 1.5%. (Control).
5. Ewasy trees sprayed with nano zinc 0.5 g / l.
6. Ewasy trees sprayed with nano zinc 1 g/l.

Zinc sulphate nano crystallite powder was synthesized by high-energy ball milling. Powder mixture conducted in a planetary ball mill to 40 h using ball to powder mass ratio of (8:1) at Tanta University, Central lab.

Recorded data:

1 - Panicle length:

It was measured after 7, 21 and 28 days from full bloom, sex ratio was calculated as total number of flowers and proportion of male to hermaphrodite flower. The floral malformation was calculated as a percentage.

2 - Number of fruits per panicle (fruit retention):

It counted after 48 days of full bloom and directly pre-harvest. At harvest time, the number of fruits per panicle and per tree counted for each treatment.

3 – Yield:

Tree yield as kg/tree estimated by multiplying the fruits/tree × the average of fruit weight (g).

4 - Plant growth:

To determine plant growth effects, samples of mature leaves grown on unfruitful shoots were randomly taken at harvest date for determine the following parameter:

a: Length and width of leaf (cm).

b: Leaf tissue content (mg / g fresh weight) of chlorophyll a, chlorophyll b, total chlorophyll (a+b) and carotenoids according to Wettestein (1957).

C: N, P, K and Zn percentages were determined in the digested solution. The another leaves samples were washed, dried ground and digested using sulphoric acid and hydrogen peroxide according to Chapman and Pratt (1961).

5 – Fruit physical and chemical properties:

At harvest time, samples of five firm ripe (commercial stage) fruits were taken from each replicate to study fruit length (mm), width (mm), fruit shape index (length/width), total soluble solids (TSS %) by hand refractometer, fruit acidity (%) and vitamin C (mg/100 ml juice), were determined as described by Association of Official Agricultural Chemists (1995).

Statistical Analysis:

Data subjected to the analysis of variance by Co-Stat program version 3 and a factorial experiment with complete block design (two seasons combined) was used (Steel and Torrie, 1980). Analysis of variance and mean comparison at 5% Duncan, 1958.

Results

1 - Panicle traits and malformation percentage:

Results in Table (1) show that Ewasy CV was highly significant in panicle length at 7, 21 & 28 days and sex ratio compared with Zebda CV, while it was less resistant to malformation than Zebda CV

Panicle length increased significantly with the increase in zinc concentration after 21 and 28 days over than control after all periods. As for, sex ratio, no clear effects was observed by nano zinc. Nano zinc treatments 1 g/l and 0.5 g/l decreased malformation percentage with 42-55% compared with control, respectively.

The interaction between cultivars × nano zinc treatments was insignificant in panicle length at 7 & 21 days. The highest significantly value of panicle length at 7 days was noticed with Ewasy CV treated with 0.5 & 1 g/l nano zinc after 7 days and 1 g/l nano zinc after 21 days, while the lowest values was occurred at untreated Zebda after 21 days. In addition, Ewasy at control treatment recorded significantly the highest malformation percentage, while Zebda at 0.5 g/l nano zinc have significantly the low malformation percentage.

Table 1: Panicle length at 7, 21 and 28 days' age and sex ratio as well as malformation % of Zebda and Ewasy mango cultivars affected by different concentrations of nano-zinc

Characters / Treatments		Panicle length at 7 days	Panicle length at 21 days	Panicle length at 28 days	Sex ratio	Malformation (%)
A. cultivars:						
Zebda		4.0	8.1	17.4	28.8	17.6
Ewasy		9.9	15.2	22.5	39.2	24.8
F-Test		**	**	**	**	**
B. Nano Zinc:						
0.5 g/l		8.5 a	10.2 b	20.3 b	30.2 b	14.2 c
1 g/l		8.5 a	16.7 a	26.7 a	36.5 a	18.1 b
Control		3.8 b	8.0 c	12.8 c	35.4 a	31.4 a
F-Test		**	**	**	**	**
LSD at 5%		1.4	0.9	2.1	3.6	1.8
C. Interaction AxB:						
Zebda	0.5 g/l	4.3 b	7.3 d	18.7 a	25.3 a	11.6 d
	1 g/l	4.2 b	11.3 c	24.3 a	33.2 a	18.1 c
	Control	3.5 b	5.5 e	9.3 a	27.9 a	23.1 b
Ewasy	0.5 g/l	12.7 a	13.0 b	22.0 a	35.2 a	16.8 c
	1 g/l	12.8 a	22.0 a	29.2 a	39.8 a	18.1 c
	Control	4.2 b	10.5 c	16.3 a	42.8 a	39.6 a
F-Test		**	**	NS	NS	**
LSD at 5%		1.9	1.3	--	--	2.5

In this table and the following the data in the table expressed as a means of 2015 and 2016 seasons.
Means in each column followed by the same letter(s) did not differ at < 0.50 according to Duncan's multiple-range test.

2 - Fruit retention and yield/tree:

Data in Table 2 indicated that the fruit retention at 48 days was highly significant in Ewasy than Zebda, CV while, at harvest date and fruit weight was the vice versa. The fruit number and yield/tree in Ewasy was higher than Zebda.

Nano zinc 0.5 g/l treatment significantly increased retention fruit at 48 days than 1g/l treatment and control. The fruit retention at harvest date was the highest in both nano zinc concn. compared with control. Nano zinc treatments 0.5 g/l and 1 g/l gave the highest values in fruit weight and yield /tree. The increase percentages were 41.45, 44.97 and 33.74, 57.36 respectively compared with untreated trees.

The interaction between cultivars × nano zinc treatments were insignificant in fruit retention at 48 days and at harvest date. The Ewasy at control had the lowest fruit retention at harvest date. The interaction between control or 1 g/l treatment with Zebda CV gave superior in fruit weight, while the lowest values came from the interaction between control or 0.5 g/l treatment with Ewasy CV Nano zinc 1 g/l treatment with Ewasy CV showed maximum fruit number and fruit yield/tree, while the interaction between control treatment with Zebda CV had the lowest values.

Table 2: Retention fruit at 48 days and at harvest date, fruit weight and number as well as yield /tree of Zebda and Ewasy mango cultivars affected by different concentrations of nano-zinc

Characters / Treatments		Retention fruit at 48 days	Retention fruit at harvest	Fruit weight (g)	Fruit number/tree	Fruit yield /tree (kg)
A. cultivars:						
Zebda		14.8	2.00	465.6	78.3	35.9
Ewasy		19.6	1.78	263.1	185.2	49.0
F-Test		**	**	**	**	**
B. Nano zinc:						
0.5 g/l		21.7 a	2.42 a	325.1 c	144.7 a	43.6 b
1 g/l		19.8 b	2.50 a	393.5 a	148.3 a	51.3 a
Control		10.0 c	0.75 b	374.5 b	102.3 b	32.6 c
F-Test		**	**	**	**	**
LSD at 5%		1.8	0.17	11.4	8.3	2.3
C. Interaction AxB:						
Zebda	0.5 g/l	20.0 a	2.50 a	390.7 b	92.3 d	36.1 d
	1 g/l	17.5 a	2.50 a	505.3 a	85.7 d	43.3 c
	Control	6.80 a	1.00 b	500.8 a	56.8 e	28.5 e
Ewasy	0.5 g/l	23.3 a	2.33 a	259.5 d	197.0 b	51.1 b
	1 g/l	22.2 a	2.50 a	281.7 c	210.8 a	59.3 a
	Control	13.2 a	0.50 c	248.2 d	147.7 c	36.7 d
F-Test		NS	*	**	**	**
LSD at 5%		--	0.21	16.1	11.8	3.3

In this table and the following the data in the table expressed as a means of 2015 and 2016 seasons.
Means in each column followed by the same letter(s) did not differ at < 0.50 according to Duncan's multiple-range test.

3 - Leaf physical characteristics and pigments contents:

Leaf length of Ewasy CV displayed the highest value. Also, leaf width as well as chlorophyll A, B and total content were higher than Zebda CV On the contrary, content of leaf carotene in Zebda CV was high significantly compared with Ewasy CV (Table 3).

The tested nano zinc treatments was high significantly with leaf physical characteristics and pigments contents. The nano zinc 1 g /l treatment recorded the highest values.

The interaction between cultivars and nano zinc treatments was insignificant with leaf width only. But, the interaction between Ewasy CV recorded the highest values in respect of leaf length and pigments content under nano zinc 1 g /l treatment. However, the interaction between Zebda and control recorded the least values in leaf length and chlorophyll pigments while Ewasy and control recorded the least carotene value.

Table 3: Leaf length and width, chlorophyll A, B, and total as well as carotene pigments of Zebda and Ewasy mango cultivars as affected by nano-zinc (over 2015 and 2016 seasons)

Characters / Treatments		Leaf length (cm)	Leaf width (cm)	Chlorophyll A (mg / g fresh weight)	Chlorophyll B (mg / g fresh weight)	Total chlorophyll (mg / g fresh weight)	Carotene (mg / g fresh weight)
A. cultivars:							
Zebda		22.2	2.8	1.417	1.939	3.356	2.728
Ewasy		38.4	6.4	1.584	2.108	3.692	2.647
F-Test		**	**	**	**	**	**
B. Nano chitosan:							
0.5 g/l		30.0 b	4.6 ab	1.743 b	2.357 b	4.101 b	2.960 b
1 g/l		33.3 a	5.3 a	1.901 a	2.488 a	4.390 a	3.064 a
Control		27.7 c	4.0 b	0.857 c	1.226 c	2.083 c	2.038 c
F-Test		**	**	**	**	**	**
LSD at 5%		1.8	0.8	0.0013	0.0013	0.041	0.0013
C. Interaction AxB:							
Zebda	0.5 g/l	21.7 d	2.8 a	1.617 d	2.242 d	3.859 d	2.874 d
	1 g/l	23.2 d	3.0 a	1.814 c	2.360 c	4.174 c	2.974 c
	Control	21.8 d	2.7 a	0.820 f	1.216 f	2.036 f	2.334 e
Ewasy	0.5 g/l	38.3 b	6.3 a	1.870 b	2.473 b	4.342 b	3.046 b
	1 g/l	43.3 a	7.5 a	1.989 a	2.616 a	4.605 a	3.154 a
	Control	33.7 c	5.3 a	0.894 e	1.236 e	2.130 e	1.741 f
F-Test		**	NS	**	**	**	**
LSD at 5%		2.5	--	0.0018	0.0018	0.057	0.0018

In this table and the following the data in the table expressed as a means of 2015 and 2016 seasons.
Means in each column followed by the same letter(s) did not differ at < 0.50 according to Duncan's multiple-range test.

4 - Leaf mineral contents:

Ewasy cv trees showed significantly higher values of leaf mineral content compared with Zebda CV (Table 4).

Generally, effect of nano zinc treatments showed high significantly increase of leaf mineral content compared control treatment.

Reversely, the effect of interaction between cultivar and nano zinc treatments on leaf mineral content was insignificant.

5 - Fruit physical and chemical properties:

Data in Table (5) exhibited high significant differences between the two tested cultivars for all studied fruit properties except fruit width was insignificant between them. In this connection, Zebda CV fruits had higher values for length and shape compared to Ewasy CV fruits. As for chemical traits the lowest values of TSS, total acidity percentages and vitamin C of fruit juice was higher in Ewasy than Zebda CV.

In generally, nano zinc treatments recorded the highest values in fruit length and width as well as fruit juice content of TSS and vitamin C compared to control treatment. The effect of nano zinc treatments was insignificant on fruit shape and total acidity percentage of fruit juice.

Interaction between cultivars and nano zinc treatments had significant effects for studied fruit properties except fruit shape and total acidity percentage of juice fruit. In Zebda CV x nano zinc 1 g /l treatment fruit length was recorded the highest values. While the lowest values came from Ewasy CV and control treatment. However, the highest values of fruit width came with Ewasy CV and nano zinc 1 g /l treatment, while the lowest values came from Ewasy CV and control treatment. Therefore, the values of total soluble solids was significantly the highest in Ewasy CV and 0.5 g /l treatment, while the lowest values came from Zebda CV and control treatment. The highest values of vitamin C was obtained from Zebda CV and nano zinc 1 g /l treatment, whilst, the lowest values came from Ewasy CV and nano zinc 0.5 g /l treatment.

Table 4: Means of leaf mineral contents of Zebda and Ewasy mango cultivars as affected by nano-zinc (over 2015 and 2016 seasons)

Characters / Treatments		N%	P%	K%	Zn (ppm)
A. cultivars:					
Zebda		2.29	0.23	1.76	32.4
Ewasy		2.42	0.26	1.80	33.5
F-Test		**	*	**	**
B. Nano chitosan:					
0.5 g/l		2.39 a	0.26 b	1.86 a	33.1 b
1 g/l		2.49 a	0.26 a	1.79 b	37.7 a
Control		2.19 b	0.22 c	1.69 c	28.1 c
F-Test		**	**	**	**
LSD at 5%		0.11	0.001	0.001	0.08
C. Interaction AxB:					
Zebda	0.5 g/l	2.35 a	0.24 a	1.84 a	32.5 a
	1 g/l	2.44 a	0.25 a	1.77 a	37.2 a
	Control	2.07 a	0.22 a	1.67 a	27.5 a
Ewasy	0.5 g/l	2.43 a	0.27 a	1.89 a	33.6 a
	1 g/l	2.53 a	0.27 a	1.81 a	38.3 a
	Control	2.31 a	0.23 a	1.71 a	28.7 a
F-Test		NS	NS	NS	NS
LSD at 5%		--	--	--	--

In this table and the following the data in the table expressed as a means of 2015 and 2016 seasons.
Means in each column followed by the same letter(s) did not differ at < 0.50 according to Duncan's multiple-range test.

Table 5: Fruit length, width, shape, total soluble solids (TSS), acidity and vitamin C of Zebda and Ewasy mango cultivars as affected by nano-zinc (over 2015 and 2016 seasons)

Characters / Treatments		Fruit length (mm)	Fruit width (mm)	Fruit shape	TSS %	Acidity (%)	Vitamin C (mg/100 ml juice)
A. cultivars:							
Zebda		124.7	70.7	1.76	20.4	1.067	30.8
Ewasy		97.9	72.2	1.36	24.7	1.350	29.6
F-Test		**	NS	**	**	**	**
B. Nano chitosan:							
0.5 g/l		115.0 a	75.7 a	1.53 a	23.6 a	1.225 a	29.1 b
1 g/l		114.2 a	72.1 b	1.58 a	23.3 a	1.192 a	31.2 a
Control		104.7 b	66.4 c	1.57 a	20.8 b	1.208 a	30.3 a
F-Test		**	**	NS	**	NS	**
LSD at 5%		4.7	3.0	--	1.5	--	1.0
C. Interaction AxB:							
Zebda	0.5 g/l	122.2 a	71.4 b	1.71 a	20.7 b	1.150 a	30.7 a
	1 g/l	128.0 a	72.4 b	1.77 a	20.8 b	1.050 a	31.2 a
	Control	124.0 a	68.4 bc	1.81 a	19.8 b	1.000 a	30.7 a
Ewasy	0.5 g/l	107.9 b	80.3 a	1.34 a	26.5 a	1.300 a	27.5 b
	1 g/l	100.5 c	71.9 a	1.40 a	25.7 a	1.333 a	31.3 a
	Control	85.4 d	64.4 c	1.33 a	21.8 b	1.417 a	30.0 a
F-Test		**	**	NS	*	NS	**
LSD at 5%		6.6	4.3	--	2.2	--	1.3

In this table and the following the data in the table expressed as a means of 2015 and 2016 seasons.
Means in each column followed by the same letter(s) did not differ at < 0.50 according to Duncan's multiple-range test.

Discussion

Ewasy CV displayed high values of their tested attributes in panicle length, sex ratio, retention fruit, yield, leaf physical characteristics and pigments contents and leaf mineral content. However, Zebda CV shwoed high significantly leaf carotene content as well as resistance of malformation

percentage compared with Ewasy CV However, differences between the two mango CVS in their parameters are varietal differences that go back to genetic composition. In this respect, Bally (2006) reported that growth vigor of a mango CV is an inherent property ascribing to the genetic make-up of the cultivar. Outweigh of a mango cv in growth traits especially the area of photosynthetic leaves indicates its higher capacity for accumulating photosynthesis. It is well known that mango cvs; as any other plant cultivars; differ greatly in response of their genetic make up to the environmental factors that affecting developmental processes and ability to thrive benefit from the available growth factors. (Zuo *et al*., 2007). Anyhow, the cultivars Zebda and Hindi Anshas were reported to be rarely affected and Awais moderately susceptible of floral malformation (Azzous *et al.*, 1978). The malformation resistant capacity of Zebda was further confirmed by El-Ghandour *et al.* (1979) when they recorded that extracts of shoots or inflorescence of Zebda strongly retarded the growth of the F. moniliforme var. subglutinans in vitro. But no variety in Pakistan has been found to be free from the disease (Ali 1977). In addition, Azza (2015) reported that, Saddeka CV followed by Ewasy CV were the most susceptible ones to the disease incidence and Keitt was the lowest affected one.

Nano zinc treatments increased fruit yield as number of fruit or weight / tree and decreased malformation percentage as well as improving other studies attributes especially with nano zinc 1 g/l treatment. However, treatments of 0.5 g/l and 1 g/l gave significantly high values in fruit weight and yield /tree, i. e, the increase percentages were 41.45 & 44.97 and 33.74 & 57.36 respectively compared with untreated trees. The nano zinc treatments increased of yield compared of control treatment may be attributed to the indirect impact of increasing the number of fruit / tree affected by these treatments. Similarly, the results of this study are in agreement with Baiea *et al.,* (2015), they reported that the zinc sulfate application decreased the number of malformed panicles/trees of Keitt mango. Also, Zn application of mangoes significantly increased number of flower panicle, fruits matured panicle, leaf Zn concentrations, fruit size, peel thickness, fruit weights at harvest and after ripening and fruit yield tree, whereas it reduced malformed panicles and early fruit drop. However, flower sex ratio and fruit set remained statistically unaffected. Similarly, fruit quality in terms of total soluble solids, flesh color, aroma, flavor and overall acceptability significantly improved as compared to control. Foliar application mitigated Zn deficiency more effectively than the soil application. (Masroor et al., 2016). Kamiab and Zamanibahramabadi (2016) found that The highest percentages of initial and final fruit set and yield per shoot were observed in Shokufeh cultivar and fertilizer spraying in two stages nano-chelate super plus ZFM 2g/l (Zinc, Iron and Manganese), and the lowest percentage of initial and final fruit set was observed in control in all tested cultivars. The simple effect of spraying time on fruit abscission was significant in 1% level and also percentage of fruit abscission decreased about 25% compared to control in application in two times spraying on quantitative and qualitative characteristics of almond commercial cultivars. Davarpanah et al., (2016) obtained that application of Zn and B increased the leaf concentrations A single foliar spray with relatively low amounts of B or Zn nano-fertilizers (34 mg B tree−1 or 636 mg Zn tree−1, respectively) led to increases in pomegranate fruit yield, and this was mainly due to increases in the number of fruits per tree. The effect was not as large with Zn as with B. Fertilization with the highest of the two doses led to significant improvements in fruit quality, including 4.4–7.6% increases in TSS, 9.5–29.1% decreases in TA, 20.6–46.1% increases in maturity index and 0.28–0.62 pH unit increases in juice pH, whereas physical fruit characteristics were unaffected. So, Maximum yield rate of treated nano zinc oxide and the lowest yield rate to the control treatments without foliar zinc oxide was obtained on wheat. Afshar *et al.,* (2014). Zn is required for the synthesis of tryptophan which is a precursor of IAA, it also has an active role in the production of an essential growth hormone auxin (Alloway 2004 and Brennan 2005). The application of nanostructured materials, designed for sustainable crop production, reduces nutrient losses, suppresses disease and enhances the yields. Nanomaterials (NMs), with a particle size less than 100 nm, influence key life events of the plants that include seed germination, seedling vigor, root initiation, growth and photosynthesis to flowering. Additionally, NMs have been implicated in the protection of plants against oxidative stress as they mimic the role of antioxidative enzymes such as superoxide dismutase (SOD), catalase (CAT) and peroxidase (POX). However, besides their beneficial effects on plants, applications of NMs have been proved to be phytotoxic too as they enhance the generation of reactive oxygen species. Nano compounds rapidly and completely absorbed by the plant and will fix it as well as nutritional needs and deficiencies. Khan *et al.,* (2017).

Recommendation

From result of this research we recommend using the nano zinc treatment as a foliar spray on mango trees concentration of 1 g/l to improve the vegetative growth, fruit quality physical and chemical properties, also increase fruit weight and yield /tree and increase percentage were 44.97 and 57.36 respectively. However, 1 g/l and 0.5 g/l treatments decreased malformation percentage with 42-55% compared with control, respectively.

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