Response the Naomi mango trees to foliar application of some nutrients

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Abstract

The present study was conducted during the three consecutive seasons of 2019, 2020 and 2021 in a private mango orchard situated at Draw region, Aswan governorate where the texture of the soil is sandy. Among various nutrients, the role of Ca, Zn and B is very important. Therefore, balanced application and uptake of Ca, B and Zn can improve the quality and yield of mango trees. So, a field study was conducted with the hypothesis that combined application of these nutrients would be effective to increase the vegetative growth and improve yield and quality of Naomi Mango trees. These treatments significantly improved the shoot length, leaf area and leaf chlorophyll as well as panicle length and number/tree, yield, total soluble solids and sugar contents. Data indicated that Ca plus Zn was effective than other treatment and control. Moreover, Ca plus Zn was found more effective in growth traits, while Ca plus B was found more efficacious of quality and yield of Naomi mango trees. It is concluded that to improve the growth, yield and quality of Naomi Mango trees would to spray calcium beside zinc or boron.

Keywords: Naomi; Foliar application; Calcium; Boron; Zinc; Quality; Yield

Introduction

Mangoes is one of the most popular and favorite fruits in world. It has been considered the King of fruits and is widely cultivated in the tropical and subtropical regions. Mango cultivated areas in Egypt reached 321040 fed. with a total production about 766128 tons **[1]**.

Climatic has a significant effect on growth and productivity of all fruit crops. Growing and producing of Mango yielding is meeting by difficulties under tropic and sub tropic area of the world owing for shifting weather patterns **[2]**. Mango phenological stage cycle may be affected by a change in temperature, precipitation, light, humidity and greenhouse gases **[3]**. The anticipated climate changes and increasing CO_2 levels with global warming can result in greater changes in mango flowering and ultimately low yields of mangoes. The climate, especially high temperature during the flowering season induce erratic flowering in mango **[4]**. To obtain higher yields, it is necessary to improve nutrient supply and fertilizer use efficiency to minimize emissions of greenhouse gases. Due to high temperature in summers, mango gets vigorous vegetative growth and in winter early flowering issue becomes the reason for low yield **[2]**. Increasing nutrients application will increase mangoes yield but will not halt the decline in flowering or fruit drop, which is directly influenced by climatic factors. So, under changing climate, the management of natural resources like nutrients and water are a possible solution to the upcoming menace.

One of the most important elements determining the quality of fruit in calcium. It is wanted for division and elongation of cells **[5]**.

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It is very important in controlling fruit disorders, deficiency of Ca is low due to calcic parent material of soil. The problem in plants may be due to poor distribution after uptake **[6]**. Also, micronutrients play a vital role in macronutrients translocation and functions of many metabolic processes in plants as respiration, cell wall development, formation of chlorophyll, photosynthesis, hormone synthesis, fixation of nitrogen and enzyme activities **[7]**. Zinc is a crucial trace element that in many enzymatic reactions, in regulating the protein and carbohydrate metabolism and development of plant growth **[8]**. In fruits many disorders are relevant to B deficiency, even when B is in ample supply, suggesting these disorders are physiological in nature and related to the mobility of B in the plant tissues **[9]**.

Then, the aim of the current study was to investigate the effects of foliar application of calcium, zinc and boron on growth, yield and quality of Naomi mango trees.

Materials and Methods

The present study was conducted during the three consecutive seasons of 2019, 2020 and 2021 in a private mango orchard situated at Draw region, Aswan governorate where the texture of the soil is sandy with a water table depth not less than two meters and the orchard soil analysis according to **[10]** was shown in Table (1). Eleven-year-old Keitt mango trees budded on mango seedling rootstocks and planted at 3x4 meters apart were selected for this study. five nutrition treatments were applied and executed in a randomized complete block design (RCBD) with three replications, three trees per each. The details of the nutrition treatments are given in Table (2). Three foliar applications of nutrition were applied for the three seasons in 1st March at the growth stage and 15th May after fruit setting. All mango trees received the regular agricultural and horticultural practices, which were already followed in the mango orchard including pruning, hoeing, irrigation with Nile water as well as pests, pathogens, and weed control. Generally, the following measurements were recorded during the two studied seasons:

- Growth aspect measurements:

Ten secondary branches with 1.5 cm diameter were labeled in February for each tree. Twenty new shoots in the growth flush were chosen to measure shoot length (cm), the number of leaves/ shoot and leaf area (cm^2) was measured according the following equation reported by **[11].** L.A. = 0.70 (L x W) – 1.06 Where L.A. = leaf area (cm^2), L and W= maximum leaf length and width (cm), respectively. Also, leaf Chlorophyll content was measured by Chlorophyll meter (SPAD).

Table 1: The physical and chemical properties of the experimental site.

Characters	Value	Characters	Value
Particle size distribution		**Macronutrients values**	
Sand (%)	72.22	Total N (%)	0.09
Silt (%)	17.78	P (ppm, Olsen method)	5.1
Clay (%)	10.00	K (ppm, ammonium acetate)	69.9
Texture	Sandy	Mg (ppm)	10.9
pH (1:2.5 suspension)	8.11	EDTA extractable micronutrients (ppm)	
EC (1:2.5 extract) (mmh°s/1 cm/25-°C)	0.97	Zn	0.31
		Fe	0.60
Organic matter %	0.30	Mn	0.41
$CaCO_3$ (%)	1.29	Cu	0.22

Table 2. Details of the experimental nutrition treatments for the field application as foliar spray of mango cv. Keitt.

Treatments	Nutrition
T_1	Control (water spraying)
T_2	Spray with chelated with EDDTA zinc (13 zinc) 1 ml/L
T_3	Spray with Ca (6%) + Zn (1%) at 1 ml/L (InCa)
T_4	Spray with boron (15% B) at 1 ml/L (promod)
T_5	Spray Ca (7.5%) + B (2.5%) at 1 ml/L (calboro)

- Growth aspect measurements:

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Flowering aspect measurements:

At full bloom stage in April 2019, 2020 and 2021, number of panicles/tree was determined. Also, ten panicles were taken from each replicate to measure number of panicle and panicle length (cm).

Yield and physical characteristics:

At harvest, number of fruits per tree was counted, and ten fruits were randomly taken from each replicate for determination the physical and chemical parameters. The physical characteristics namely fruit weight (g), dimension (cm), flesh percentage and stone percentage.

Chemical characteristics:

1- Fruit total soluble solids (TSS %) using hand Refractometer.

2- Reducing sugar and total (%).

3- Total acidity (%) as citric acid content and ascorbic acid (mg/100 ml juice were determined according to **[12]**.

Statistical analysis:

All obtained data for the tested treatments were tabulated and statistically analyzed according to the procedure of **[13].** The individual comparisons between the studied parameters were compared by using L.S.D. at 5%.

Results

1- Vegetative growth:

Tables (3 and 4) explain the spraying effects of zinc or boron elements individually or in a compound with calcium on the shoot length, leaf area and total chlorophylls of Naomi mango trees during 2019, 2020 and 2021 seasons. It is obvious that the results follow the same over the years of research. Such data show that spraying of any zinc or boron alone or combined with calcium significantly increased these traits compared to spray water (control). The maximum

reading of such growth feature was seen due to spray calcium plus zinc (T_3). On other hand, the minimum values of the growth feature were found on the trees that were sprayed with water (control, T_1). The registered leaf number (14.78, 16.51, 17.33, 16.83 & 16.61 leaf), leaf area was (60.11, 64.12, 68.37, 63.48 & 66.79 cm^2) and total chlorophyll (36.58, 38.66, 41.04, 38.31 & 40.64 SPAD as an av. of the three studied seasons) due to spray with water (T_1), zinc (T_2), calcium plus zinc (T_3), boron (T_4) and calcium plus boron (T_5), respectively. Then, the attained increment of the leaf area was (6.67, 13.74, 5.61 & 11.11%) and total chlorophylls was attained (5.69, 12.19, 4.73 & 11.10% as an av. of the three studied seasons) due to T_2 to T_5 compared to T_1 (check treatment), respectively. Therefore, spraying with any nutrition significantly increased the total leaf surface area and vegetative growth of mango trees.

Table (3). Impact of spraying of calcium, zinc and boron on shoot length and leaf number of Naomi mango trees during 2019, 2020 and 2021 seasons.

Treat.	Shoot length (cm)				Leaf number/shoot			
	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	7.27	7.20	7.25	**7.24**	15.53	13.89	14.93	**14.78**
T_2	8.20	8.53	8.19	**8.31**	17.10	15.64	16.79	**16.51**
T_3	8.67	8.60	8.71	**8.66**	17.88	16.43	17.68	**17.33**
T_4	7.68	7.63	7.65	**7.65**	16.61	14.76	19.13	**16.83**
T_5	7.98	7.86	8.03	**7.96**	17.43	15.56	16.83	**16.61**
LSD 5%	**0.38**	**0.33**	**0.30**	**0.18**	**1.05**	**1.86**	**1.01**	**0.61**

T_1: Control (water spraying), **T_2:** Spray with chelated zinc, **T_3:** Spray with InCa., **T_4:** Spray with boron, **T_5:** Spray with calboron.

Table (4). Impact of spraying of calcium, zinc and boron on leaf area and Total chlorophyll of Naomi mango trees during 2019, 2020 and 2021 seasons.

Treat.	Leaf area (cm^2)				Total chlorophyll (SPAD)			
	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	62.74	52.64	64.95	**60.11**	34.58	40.95	34.20	**36.58**
T_2	66.84	56.13	69.39	**64.12**	36.83	43.24	35.91	**38.66**
T_3	71.19	60.11	73.81	**68.37**	39.10	45.90	38.12	**41.04**
T_4	66.11	55.76	68.58	**63.48**	36.48	42.85	35.59	**38.31**
T_5	69.58	58.60	72.18	**66.79**	38.73	45.51	37.68	**40.64**
LSD 5%	**3.28**	**3.11**	**3.63**	**2.05**	**1.78**	**2.11**	**1.63**	**1.15**

2- Flowering performance:

Data in Table 5 declared the foliar application effects of zinc or boron alone or combined with calcium on flowering traits namely number of panicles/tree and panicles length of Naomi mango trees during three studied seasons. Results indicated that there were significant differences in these flowering traits as result of implementation of different treatments. Spraying zinc, boron alone or combine of it with calcium significantly increased number of panicles/tree and panicles length compared to control. The highest values of these traits were recorded due to spray with zinc plus calcium (T_3) followed spray with zinc (T_2) or boron plus calcium (T_5). The highest panicles/tree (60.13, 57.73 & 57.70) panicles length (41.94, 40.13 & 39.41 cm as an av. of three studied seasons) due to T_3, T_2 and T_5 compared the least values (49.30 & 35.92) due to spray water (control, T_1). Hence, the increment percentage of panicle number attained (21.97, 17.10 &

17.04%), panicles length (16.76, 11.72 & 9.72 as an av. of the three studied seasons) due to T_3, T_2 and T_5 compared to T_1, respectively.

Table (5). Impact of spraying of calcium, zinc and boron on Panicles number/tree and Panicle length (cm) of Naomi mango trees during 2019, 2020 and 2021 seasons.

Treat.	Panicles number/tree				Panicle length (cm)			
	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	47.80	49.70	50.40	**49.30**	32.89	36.64	38.22	**35.92**
T_2	55.90	58.20	59.10	**57.73**	36.85	40.86	42.67	**40.13**
T_3	58.40	60.50	61.50	**60.13**	38.27	42.93	44.61	**41.94**
T_4	52.30	54.10	54.90	**53.77**	34.76	38.65	40.22	**37.88**
T_5	56.20	58.10	58.80	**57.70**	36.22	40.18	41.84	**39.41**
LSD 5%	**2.39**	**2.75**	**2.65**	**1.58**	**1.78**	**2.11**	**2.21**	**1.22**

3- Yield

Data in Table (6) cleared that the spraying of Naomi mango trees with calcium plus either zinc or boron significantly increased the number of fruit/tree and yield/tree compared to spray water (check treatment). The maximum yield components were recorded on the trees that were spray with calcium plus zinc (T_3), followed by zinc (T_2), whereas least one was with the comparison treatment (T_1). The obtained yield/tree was 15.85, 21.52, 23.82, 19.88 and 21.41 kg/tree as an average of three studied due to use T_1, T_2, T_3, T_4 and T_5, respectively. Then the increment of yield/tree as averages of three seasons was 35.77, 50.28, 25.43 and 25.08 as a result of using T_2, T_3, T_4, and T_5, compared to T_1 (check treatment) respectively. Therefore, it is clear that the spraying of these nutrients on mango trees has beneficial effects.

Table (6). Impact of spraying of calcium, zinc and boron on fruit number and yield of Naomi mango trees during 2019, 2020 and 2021 seasons.

Treat.	Fruits/tree				Yield/tree (kg)			
	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	32.40	35.20	37.80	**35.13**	13.31	15.98	18.25	**15.85**
T_2	38.60	42.10	45.30	**42.00**	17.39	21.80	25.38	**21.52**
T_3	39.70	43.30	46.60	**43.20**	18.90	24.89	27.67	**23.82**
T_4	36.60	39.80	43.30	**39.90**	15.86	20.28	23.50	**19.88**
T_5	37.40	40.70	44.20	**40.77**	17.10	21.78	25.36	**21.41**
LSD 5%	**1.35**	**1.93**	**2.11**	**1.08**	**0.85**	**1.09**	**1.13**	**0.63**

4- Fruit Quality

It is evident from Tables (7 to 9) that application of the different nutrition significantly improved the fruit quality in terms of increasing the fruit weight, pulp %, T.S.S.% and sugar contents as well as, vitamin C content and decreasing the total acidity compared spray water one (control). The highest values of fruit traits were recorded on the trees that were treated with calcium plus either zinc or boron, respectively.

The recorded average fruit weight was (449.3, 513.9, 544.1, 495.5 and 524.2) of the trees that treated with T_1, T_2, T_3, T_4 and T_5, respectively. The respective TSS was 14.79, 15.32, 15.84, 15.49 & 15.83%. Hence, the average increment percentages of the fruit weight were attained 14.43, 21.15, 10.03 & 16.72% due to using T_2, T_3, T_4 and T_5 treatments, compared to T_1 (check treatment)

respectively. In addition, the respective average increment of TSS was attained 3.58, 7.10, 4.73 & 7.03%, respectively.

Table (7). Impact of spraying of calcium, zinc and boron on fruit weight and Fruit pulp % of Naomi mangos during 2019, 2020 and 2021 seasons.

Treat.	Fruit weight (g)				Fruit pulp %			
	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	409.8	454.3	483.3	**449.1**	72.60	70.18	73.10	**71.96**
T_2	450.7	528.1	563.1	**513.9**	75.22	72.86	75.86	**74.65**
T_3	476.9	560.5	594.8	**544.1**	76.39	74.10	77.11	**75.87**
T_4	433.3	510.6	542.6	**495.5**	74.65	74.48	77.65	**75.59**
T_5	459.8	538.9	573.9	**524.2**	75.81	73.53	76.64	**75.33**
LSD 5%	**22.95**	**24.35**	**27.18**	**14.68**	**1.98**	**1.87**	**2.09**	**1.18**

Table (8). Impact of spraying of calcium, zinc and boron on TSS, Total sugars and Reducing sugar of Naomi mangos during 2019, 2020 and 2021 seasons.

Treat.	TSS (%)				Total sugars (%)				Reducing sugar (%)			
	2019	2020	2021	Mean	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	14.93	14.22	15.23	**14.79**	12.24	11.54	12.47	12.08	4.41	4.21	4.61	**4.41**
T_2	15.53	14.50	15.92	**15.32**	12.91	12.53	13.14	12.86	4.63	4.41	4.82	**4.62**
T_3	15.86	15.41	16.26	**15.84**	13.15	12.76	13.39	13.10	4.75	4.52	4.93	**4.73**
T_4	15.51	15.05	15.91	**15.49**	12.88	12.50	13.11	12.83	4.65	4.43	4.80	**4.63**
T_5	15.84	15.39	16.25	**15.83**	13.06	12.68	13.31	13.02	4.70	4.51	4.90	**4.70**
LSD 5%	**0.49**	**0.43**	**0.54**	**0.29**	**0.33**	**0.30**	**0.38**	**0.20**	**0.18**	**0.16**	**0.19**	**0.11**

Table (9). Impact of spraying of calcium, zinc and boron on V.C. (mg/100g) and acidity of Naomi mango trees during 2020 and 2021 seasons.

Treat.	V.C. (mg/100 g)				Acidity (%)			
	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	42.89	43.36	44.19	**43.48**	0.28	0.27	0.28	**0.27**
T_2	44.82	45.27	46.05	**45.38**	0.26	0.24	0.26	**0.25**
T_3	45.38	45.86	46.71	**45.98**	0.25	0.24	0.25	**0.25**
T_4	44.50	44.95	45.84	**45.10**	0.27	0.25	0.26	**0.26**
T_5	45.43	45.93	46.68	**46.01**	0.26	0.24	0.25	**0.25**
LSD5%	**1.43**	**1.46**	**1.55**	**0.93**	**0.02**	**0.02**	**0.02**	**0.01**

Discussion

Spray nutrients, i.e. calcium, zinc and boron may contribute for growth, yielding and fruit quality that are beneficial. Calcium having an important role in determining the growth in plants, since it is required for cell elongation and division**.** The increment in the growth parameters by calcium application could be attributed to the role of calcium in cell formation and its prevention of cellular degeneration **[14,15,16,17].** The obtained results agreed with **[18]** on Naomi and Ewais mango cultivars. The different levels of $ZnSO_4$ improved the shoot length, number of leaves/ shoot and leaf area of mango tree suggested that Zn promoted vegetative growth in terms of plant height, trunk girth and spread of plants **[19,20].**

Our results also pointed out that foliar spraying with Ca plus or Ca plus Zn led to improve growth traits as compared to the control. The beneficial effects of spraying boron on the of Naomi

mangoes might be due to its positive effect on the synchronizing release of boron and preventing undesirable nutrient losses to the soil, water and air via direct internalization by plants and avoiding the interaction between nutrients with the microorganisms of water, soil and air as well as improving their efficiency and decreasing soil toxic **[21, 22].** Moreover, the important regulatory effect of boron in biosynthesis and translocation of sugars, activating metabolism enzymes, building of IAA, cell enlargement and division, water absorption and nutrient transport give other explanations **[23, 24]**.

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. Also, may be related to the essential role of Zinc in many enzymes for plant metabolism, protein synthesis and energy transfer **[25].**

Conclusion

These investigations indicated that the different foliar spraying treatments resulted in an increase and improve all of the studied traits compared to control. Then, it could be concluded, applying 1 ml/L of Ca plus Zn or Ca plus boron twice to give the highest yield with good fruit quality of Naomi mango trees.

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استجابة أشجار المانجو نعومي لرش بعض العناصر الغذائية

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الملخص

أجريت هذه الدراسة خلال مواسم 2019 ، 2020 ، 2021 بمزرعة خاصة تقع في مركز دراو – محافظة أسوان – مصر. لدراسة تأثير رش بعض العناصر الغذائيه علي النمو الخضري والحالة الغذائية والمحصول وخصائص ثمار المانجو النعومي. حيث تم استخدام الرش بالزنك أو البورون في صورة فردية أو خليط من الكالسيوم والبورون أو الكالسيوم والزنك إضافه إلي معامله الكنترول التي تم رشها بالماء وقد صممت التجربه بنظام القطاعات كامله العشوائيه ذات ثلاثه مكررات وشجره واحده لكل منها

وقد أظهرت النتائج ما يلي:

- أدي الرش بالعناصر المختلفه لزياده معنويه لكل من طول الفرع وعدد الاوراق ومساحه الورقه ومحتواها من الكلوروفيل مقارنه بمعامله (الكنترول) التي تم رشها بالماء.
- أظهرت جميع معاملات الرش زيادة في المحصول وتحسين خصائص الثمار من حيث زيادة وزن الثمرة ونسبة اللب وكذلك محتواها من المواد الصلبة الذائبة والسكريات وفيتامين(ج). مقارنة بالرش بالماء.
- ارتبطت زيادة النمو الخضري والحالة الغذائية للأشجار وبالتالي المحصول وخصائص الثمار نتيجه الرش بمخلوط الكالسيوم والزنك يليه الرش بالزنك أو بمخلوط الكالسيوم والبورون.

من نتائج هذه الدراسة يمكن التوصية بأهميه رش مخلوط العناصر الغذائيه مرتين خلال موسم النمو خاصه خليط الكالسيوم والزنك بمعدل 1 مل/لتر أو خليط الكالسيوم والبورون بمعدل 1 مل/لتر حيث يؤدي ذلك إلي تحسين النمو الخضري والحالة الغذائية لأشجار المانجو النعومي مع إنتاج محصول عال ذو خصائص ثمرية جيدة.

الكلمات المفتاحية: ناعومي - إضافة ورقية – كالسيوم – بورون - زنك – جودة – محصول.