

## Impact of Foliar Application of Calcium, Boron and Amino Acids on Fruit Set and Yield of Ewais and Fagry Kelan Mango Cultivars

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**Abstract:** An experiment was conducted in a private orchard located at Alexandria desert road KL65-Giza Egypt to evaluate the effect of foliar spray with different concentrations of Stopit® (calcium), Delfan Plus® (amino acids) and Boramin Ca® (calcium+ amino acids +boron) on fruit set and yield of Ewais and Fagry Kelan mango trees. These two cultivars are suffering from a gradual decrease in yield by aging. The study was conducted on 8 years old uniform in shape mango trees of Ewais and Fagry Kelan cvs, grown in sandy soil, under drip irrigation system and received the common horticultural practices. Trees were sprayed with 1000, 1500 or 2000 ppm with Stopit® containing 16% Ca W\V, Delfan Plus® containing 28.8% Amino Acids W\V and Boramin Ca® containing 6.5%Amino Acid W\V, 10.4%CaO W\V and 0.27% B W\V. Trees were sprayed three times, at the beginning of flowering, full bloom and two weeks after setting. The results indicate that tree yield increased significantly with all treatments. The effect was best as concentration increased. Boramin Ca® was the most effective treatment for improving fruit set, fruit retention and tree yield, followed by Stopit® and Delfan Plus® treatments. Treated Ewais cultivar produced higher fruit yield 67.9, 52.2 and 30.5 % in the first season and 31.1, 21.4 and 12.5 in the second season than the untreated control trees with Boramin Ca®, Stopit® and Delfan Plus® consequently. For Fagry Kelan cultivar also all treatments increased fruit yield markedly than the untreated control trees as tree yield (Kg/tree) was higher than the control by 35.5, 27.3 and 18.2% in the first season and 37, 27.3 and 19.2% in the second season respectively for the previously mentioned treatments.

**Key words:** Mango • Calcium • Amino acids • Boron • Fruit set • Yield

### INTRODUCTION

Mango is an important national crop in Egypt and within the context of Egyptian cultivars and horticultural practices, there is a wide range of yields, but even the highest yielding 6-8 tons per Fadden are below the commercial levels achieved in Florida, Mexico, Israel and elsewhere for comparably aged trees. The achieved yields in these areas range from 10 to 16 tons per acre. The most serious problems faced by growers today are low fruit set percentage, yield and inferior fruit quality. One of the most important factors responsible for low yield is inadequate pollination i. e. less fertilization which causes less fruit set and high fruit drop. Overcoming this problem by some nutrients was found to be useful for improving setting of fruits, fruit quality and yield. Attempts were made by several researchers to enhance the productivity and quality of mangoes via foliar applications of nutrients. Jutamane *et al.* [1], Singh and Maurya [2] and Wakarma *et al.* [3] showed enhancement of mango productivity as a result of boron application.

Calcium spraying increased the productivity of mango basically due to reducing abscission [4, 5]. The response of fruit trees to growth regulators and amino acids become a subject of extensive studies in the recent years. Moreover, many investigators demonstrated that cropping of many fruit trees can easily be improved by different growth regulators and amino acids [6-9]. Calcium, boron and amino acids were reported to increase initial and final fruit set which subsequently affects yield and fruits quality [8, 10].

This study was conducted to assess the effect of spraying some nutrients for better yielding of Ewais and Fagry Kelan mango cvs as their yields decrease markedly by aging.

### MATERIALS AND METHODS

This study was conducted throughout (2012 and 2013) seasons in a private orchard located at Alexandria desert road KL65 - Giza Egypt on Ewais and Fagry-Kelan mango cultivars. Thirty healthy uniform trees 8 years old

that, received the same horticultural practices were selected. Trees under investigation were sprayed with Stopit® at 1000, 1500 and 2000 ppm (commercial product produced by Yara company South Africa, containing 16% Cao W/V), Delfan Plus® at 1000, 1500 and 2000 ppm (commercial product produced by Tradecorp company Spain, containing 28.8% amino acid W\V (Free L-Alfa amino acid), 10.8% N W\V and 27.6% organic carbon), Boramin Ca® at 1000, 1500 and 2000 ppm (commercial product produced by Tradecorp company Spain, containing 6.5% amino acids W\V, 10.4% Cao W\V, 0.27% B W\V and 6.9% N W\V) and control trees sprayed with water only. Trees were sprayed three times, the first time at the beginning of flowering (first and second week of march for Ewais and Fagry-Kelan respectively), the second spray was at full bloom stage (last week of march and first of week April for Ewais and Fagry-Kelan respectively) and the third as two weeks after setting (third and fourth week of April for Ewais and Fagry-Kelan respectively). Each treatment was repeated three times on a different tree acting as replicate.

**Data Recorded:** On each tree 30 terminal shoots were tagged at the beginning of flowering for determining the following parameters:

**Initial Fruit Set:** Was determined as number of fruitlets per panicle two weeks after petal fall for panicles on tagged shoots.

**Number of Retained Fruits per Panicle:** Was determined by counting number of retained fruits per panicle at harvest (First week of August for Ewais and mid of September for Fagry Kelan).

**Fruit Retention (%):** Was determined at harvest as follows:

$$\text{Fruit retention (\%)} = \frac{\text{Average No. of fruits per panicle at harvest} \times 100}{\text{Average No. of initial fruit set per panicle}}$$

**Tree Yield (Kg):** Yield per tree was estimated by multiplying number of fruits per tree X the average of fruit weight.

**Experimental Design and Data Analysis:** The layout of experiment was complete randomized block design, each treatment was replicated three times with one tree per replicate, data were tabulated and statistically analyzed according to Snedecor and Cochran [11] and means were compared by Duncans multiple range test 5% [12].

## RESULTS AND DISCUSSION

**Initial Fruit Set:** Data in Table (1) show the effect of Stopit®, Delfan Plus® and Boramin Ca® treatments on initial fruit set of Ewais and Fagry Kelan mango cultivars. Initial fruit set per panicle was enhanced by all treatments under investigation and the differences were insignificant compared to the control. The highest initial fruit set was recorded with Boramin Ca® treatment in the first and the second seasons. Interaction data showed higher values of initial fruit set with Boramin Ca® treatments for both cultivars where the highest initial fruit set was detected with Boramin Ca® treatment at 2000 ppm concentration in both seasons. Moreover, initial fruit set was increased as the concentration increased with the supremacy of Boramin Ca®. Ewais cultivar recorded higher initial fruit set than Fagry Kelan cultivar on the average.

Table 1: Effect of conducted treatments on initial fruit set of Ewais and Fagry Kelan mango cultivars during seasons 2012 and 2013

Treatments	Conc. (ppm)	Season 2012			Season 2013		
		Ewais	Fagry Kelan	Mean	Ewais	Fagry Kelan	Mean
Stopit® (Calcium)	1000	14.87 a-d	14.33d	14.82 A	13.97 a-d	12.92j	13.50 A
	1500	15.00 a-d	14.50 c-d		13.53 d-h	13.19 g-j	
	2000	15.23 a-d	14.97 a-d		13.83 a-e	13.58 d-h	
Delfan Plus®(Amino Acids)	1000	14.80 a-d	14.43d	14.84A	13.37 e-j	13.02ij	13.36 A
	1500	15.10 a-d	14.67 b-d		13.57 d-h	13.20 g-j	
	2000	15.20 a-d	14.83 a-d		13.67 c-g	13.33 f-j	
Boramin Ca® (Calcium +Amino acids + Boron)	1000	15.57 a-c	14.60cd	15.28A	14.13 a-c	13.16 h-j	13.95 A
	1500	15.73 a-b	14.80 a-d		14.23 ab	13.42 e-i	
	2000	15.87 a	15.10 a-d		14.27 a	14.50 d-h	
Control		14.83a-d	14.20 d	14.51 A	13.77 b-f	13.48 e-j	13.63 A
Mean		15.22A	14.64B		13.83 A	13.38B	

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability

Table 2: Effect of conducted treatments on number of retained fruit per panicle at harvest of Ewais and Fagry Kelan mango cultivars during seasons 2012 and 2013

Treatments		Season 2012			Season 2013		
		Cultivars			Cultivars		
Substance	Conc. (ppm)	Ewais	Fagry Kelan	Mean	Ewais	Fagry Kelan	Mean
Stopit® (Calcium)	1000	1.60fg	1.20 jk	1.54B	1.40a-d	1.10cd	1.33B
	1500	1.86de	1.26i-k		1.50a-d	1.16b-d	
	2000	2.03cd	1.33ij		1.63a-c	1.20b-d	
Delfan Plus® (Amino Acids)	1000	1.56fh	1.16jk	1.47C	1.26b-d	1.06cd	1.26C
	1500	1.73ef	1.20 jk		1.40a-d	1.13b-d	
	2000	1.90de	1.30 i-k		1.53a-d	1.19 b-d	
Boramin Ca® (Calcium +Amino acids + Boron)	1000	2.13bc	1.20 jk	1.78A	1.70a-c	1.13 b-d	1.51A
	1500	2.26ab	1.30 i-k		1.80ab	1.16 b-d	
	2000	2.46a	1.36h-j		2.03a	1.22 b-d	
Control		1.43g-i	1.10k	1.26D	1.67b-d	0.90d	1.29C
Mean		1.90A	1.24B		1.59A	1.16B	

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability

Table 3: Effect of conducted treatments on fruit retention of Ewais and Fagry Kelan mango cultivars during seasons 2012 and 2013

Treatments		Season 2012			Season 2013		
		Cultivars			Cultivars		
Substance	Conc. (ppm)	Ewais	Fagry Kelan	Mean	Ewais	Fagry Kelan	Mean
Stopit® (Calcium)	1000	10.83ef	8.39 gh	10.47B	10.09e-g	8.55gh	9.88B
	1500	12.46cd	8.79 gh		11.12c-e	8.82 gh	
	2000	13.41bc	8.96 gh		11.82b-d	8.89 f-h	
Delfan Plus®(Amino Acids)	1000	10.63ef	8.10 h	9.98C	9.55f-h	8.19hi	9.53C
	1500	11.55de	8.21 h		10.40d-f	8.66 gh	
	2000	12.61cd	8.79 gh		11.32b-e	9.04 f-h	
Boramin Ca® (Calcium +Amino acids + Boron)	1000	13.79bc	8.24 gh	11.60A	11.99bc	8.64 gh	10.89A
	1500	14.39ab	8.48 gh		12.71ab	8.75 gh	
	2000	15.64a	9.07 gh		14.14a	9.13 f-h	
Control		9.61fg	7.78h	8.70D	8.63gh	6.64i	7.64D
Mean		12.49A	8.48B		11.18A	8.53B	

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability

**Number of Retained Fruits per Panicle at Harvest:**

Concerning effect of the tested compounds data in Table (2) show that, all tested compounds significantly increased number of retained fruits per panicle at harvest in both seasons, except Amino acids in the second season which recorded statistically equal value to the control.

Interaction results clear that, number of retained fruits per panicle at harvest increased with increasing concentration where the highest values were recorded with Boramin Ca® at 2000 ppm for Ewais cultivar in both seasons. In general all concentrations increased number of retained fruits per panicle at harvest for both cultivars comparing to the control. The above mentioned results clear that spraying Boramin Ca® containing boron, calcium and amino acids increased positively initial fruit set and number of retained fruits per panicle at harvest.

**Fruit Retention %:** All treatments significantly increased fruit retention% over the control (Table, 3). Boramin Ca® has recorded the highest effect in this regard. A direct relationship was found between fruit retention and the used concentrations. The effect was more pronounced with the Ewais cv. Regarding the Fagry Kelan cv. effect of treatments was significant but difference between them was only significant in the second season

**Tree Yield (kg):** As presented from Table (4), the tree yield increased significantly with all tested compounds compared with control in the two seasons. The highest significant yield was recorded with Boramin Ca® treatments for Ewais and Fagry Kelan cultivars in both seasons. Also, Stopit® and Delfan Plus® treatments increased yield than the control however, its effect came next to Boramin Ca® treatments in this respect.

Table 4: Effect of conducted treatments on yield (Kg/tree) of Ewais and Fagry Kelan mango cultivars during seasons 2012 and 2013

Treatments	Conc. (ppm)	Season 2012			Season 2013		
		Cultivars			Cultivars		
Substance		Ewais	Fagry Kelan	Mean	Ewais	Fagry Kelan	Mean
Stopit® (Calcium)	1000	13.74j	28.36de	23.93B	14.15h-j	16.50f-h	17.43B
	1500	18.79i	29.93c		14.71g-i	20.72bc	
	2000	21.72h	31.04bc		15.56fg	22.94a	
Delfan Plus® (Amino Acids)	1000	12.47j	26.43f	21.84C	13.16kl	17.32f	16.24C
	1500	17.43i	26.87ef		13.72j-l	18.77e	
	2000	18.16i	29.68cd		14.28j-l	20.21cd	
Boramin Ca® (Calcium +Amino acids + Boron)	1000	17.95i	29.63cd	26.17A	15.30i-k	19.44de	18.80A
	1500	20.55h	31.73b		15.90hi	21.60b	
	2000	23.30g	33.83a		16.80h-i	23.76a	
Control		12.27j	23.39g	17.83D	12.25M	15.75g-i	14D
Mean		17.64B	29.08A		14.58B	19.70A	

Means in the same column followed by the same letter (s) are not significantly different at 5% level of probability

Interaction results clear that, all tested concentrations of all used compounds significantly increased tree yield of both cultivars compared to the control except 1000 ppm which recorded insignificant differences with Ewais trees in the first season. Moreover, 2000 and 1500 ppm treatments proved to be more effective in this respect. On the other hand, the lowest yield was recorded with the control followed by 1000 ppm for the three tested treatments. Treated Ewais cultivar produced higher fruit yield 67.9, 52.2 and 30.5 % the first season and 31.1, 21.4 and 12.5 the second season than the untreated control trees with Boramin Ca®, Stopit® and Delfan Plus® consequently. For Fagry Kelan cultivar also all treatments increased fruit yield markedly than the untreated control trees as tree yield (Kg/tree) was higher than the control by 35.5, 27.3 and 18.2% the first season and 37, 27.3 and 19.2% the second season respectively for the previously mentioned treatments.

The above mentioned results clear that spraying Boramin Ca® (containing boron, calcium and amino acids) increased positively initial fruit set and number of retained fruits per panicle at harvest. The attained results are in agreement with those reported by Runi and Dong, [13], Saleh and El-Monem [14] and Singh and Maurya [2] as all emphasized the effect of boron on increasing the initial fruit set in mangoes.

The increase in number of retained fruits per panicle at harvest might be due to the promoting effect of boron on cell division and multiplication as well as cell elongation of the plant [15]. Also it might be attributed to the effect of boron on enhancing pollen germination, pollen tube growth, sugar synthesis and accumulation

[16, 17]. It was reported that, boron increases the photosynthetic activity and respiration rate in plants. Likewise, boron regulates metabolism involved in translocation of carbohydrates, cell wall development and RNA synthesis [18]. Simultaneously, an active involvement of boron in biosynthesis of auxins might have controlled the fruit drop and increased fruit set and retention as well up to maturity in mango [10].

The highest fruit retention was attributed to Boramin Ca® treatment at 2000 ppm. Also, Boramin Ca® had the most pronounced effect on number of fruits per tree and similar increments in tree yield was also detected. It was also noticed that, all tested concentrations increased tree yield compared to the control for both cultivars and 2000 ppm treatment proved to be more effective in this respect. These results are in harmony with those obtained by Singh *et al.* [19] who reported that, foliar spray of boric acid at 0.02% with sorbitol at 2.0% enhanced fruit set and yield of mango cv. Dashehari. Also Calcium improved yield through the highest reduction in fruit abscission induced by this compound which led to higher number of retained fruits/panicle at harvest than the control. Parallel results were found by Kumar *et al.* [20] and Hafle *et al.* [21] who reported that foliar spray of calcium nitrate at 2% recorded the highest number of fruits per tree. This might be due to that calcium sprays well maintained the middle lamella between plant cells which lead to decrease fruit drop [22]. Also, Bhatt *et al.* [23] as they indicated that, mango cv. Dashehari trees sprayed with 0.5% borax showed maximum fruit yield and fruit weight. Moreover spraying mango cv. Kesar at full bloom with sucrose 5% + boric acid 0.5% improved fruit set, fruit retention and

yield [24]. Stino *et al.* [8] indicated that spraying Langara, Ewais and Alphonso mango cultivars with Ca (NO<sub>3</sub>)<sub>2</sub> at 2% and boric acid at 0.2% significantly increased fruit set, number of fruits per tree and yield/tree.

### CONCLUSION

Foliar spray of Boramin Ca® at 2000 ppm at beginning of flowering, full blooming stage and at two weeks after setting, were the most effective treatment for increasing yield (Kg/tree) of Ewais and Fagry Kelan mango trees.

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