Journal of Sohag Agriscience (JSAS) 2019 (1):35-49 ISSN 2357-0725
Website: https://jsasblog.wordpress.com Abo-El-Ez *et al (2019)*

Effect of multi-micronutrient and spermine Foliar Application on Yield and Fruit Quality of alphonse mango

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Keywords:
multi-micronutrient
alphonse mango

Abstract

This study was carried out to assess the influence of foliar application of multi-micronutrient (250 ppm iron, 200 ppm zinc and 100 ppm boron (and polyamine (spermine) at two concentrations (0.05 and 0.1 mM/Lit) once individually at 7 cm long grown panicles, during full bloom and at initial fruit set stage on alphonse mango trees cvs to enhance leaf micronutrient content, blooming characteristics, fruiting aspects, fruit quality upon harvest during 2017 and 2018 growing seasons. the result showed that The multi-micronutrient treatment at various treatments spraying dates (7cm long grown panicles, full bloom and initial fruit set) with alphonse variety could be consider a useful technology for improving leaf zinc content (mg/100g), fruit set (%), fruit number/tree, fruit yield (Kg/tree), fruit weight (g), fruit peel weight (g) and fruit total soluble solids (%) and reducing fruit drop (%). Also, the spermine treatment at 0.05 and 0.1 mM/Lit. for improving sex expression (%) and fruit TSS/acid ratio.

INTRODUCTION

Mango (Mangifera indica L.) is one of the most important fruit crops in tropical and subtropical regions of the world under the family of Anacardiaceae, ranking the 5th amongst fruit production and consumption worldwide **(Xiuchong *et al.*, 2001).** Mango fruits are popular among the consumers and have high commercial value **(Rahayu *et al.*, 2013).** The leading mango producers in the world are India, China, Mexico and Thailand (FAO, 2015).

In addition, Mangoes can be considered as a good source of dietary antioxidants, such as ascorbic acid, carotenoids and phenolic compounds **(Ribeiro *et al.*, 2007).** B-carotene is the most abundant carotenoid in several cultivars. These compounds are linked to anticancer and anti-inflammatory activities in the body.

In Egypt, mango is one of the most important fruits and besides delicious taste, excellent flavour and attractive fragrance, it is rich in vitamins A and C. Mango fruit may be utilized at all stages of its development but generally used at mature stages. In Egypt, the total area of mango trees reached 281153 fed. and the total fruiting area was about 212270 fed. with annual production of 440438 tons having productivity of 4133 tons per fed. during the year 2016 (Yearly Book of Statistics and Agricultural Economic Dept., Ministry of Agric., Egypt, 2016).

Micronutrients are key elements in plants growth and development. These elements play a very important role in various enzymatic activities and synthesis. Their acute deficiencies some time poses the problem of incurable nature **(Kumar, 2002).** These micronutrients also help in the uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity hormone synthesis, nitrogen fixation and reduction **(Das, 2003).** Major elements/ macronutrients are quickly taken up and utilized by the tissues of the plants by the catalyzing effect of micronutrients **(Phillips, 2004).** Various experiments have been conducted earlier of the foliar spray of micro-nutrients in mango **(Nehete *et al.*, 2011)** and shown a significant response to improve yield of fruits.

Polyamines (PAs), including putrescine (Put), spermidine (Spd) and spermine (Spm), form a class of aliphatic amines that are ubiquitous in living organisms and are known to have role in a wide range of biological processes including plant growth and development **(Kumar *et al.*, 1997 and Pandey *et al.*, 2000).** Putrescine, spermidine and spermine are the major forms of polyamines which are biosynthesized from arginine or ornithine. Polyamines arise from a common metabolic intermediate pathway as of ethylene and are believed to act antagonistically to ethylene in several physiological process like stress, senescence etc. **(Anonymous, 2004).** Recently, polyamines have been attributed to play a role in the fruit set of many crops including mango **(Malik and Singh, 2006).**

Thus, the present study was conducted to assess the influence of foliar application of multi-micronutrient (250 ppm iron, 200 ppm zinc and 100 ppm boron) and polyamine (spermine) at two concentrations (0.05 and 0.1 mM/Lit) once individually at 7 cm long grown panicles, during full bloom and at initial fruit set stage on mango trees cvs. Alphonso to enhance leaf micronutrient content, blooming characteristics, fruiting aspects, fruit quality during 2017 and 2018 growing seasons.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2017 and 2018 on alphonse mango tree. The trees are about 13- years old when this study started, grown in sandy soil and spaced 6 x 6 m apart subjected to drip irrigation system, in a mango orchard located in El-Kwamel farm, college of Agriculture, Sohag University, Egypt, is subject to mild winters and warm and dry summer. This experiment aimed to study the effect of fruit set improving chemicals, spermine at two concentrations (0.05 and 0.1 mM/Lit) and multi-micronutrient (250 ppm iron, 200 ppm zinc and 100 ppm boron) once individually on leaf nutrient status, fruit set, fruit retention and fruit quality. All the chosen trees healthy, nearly uniform in shape and size and received the same horticulture practices like weeding, irrigation, manures, fertilizers and plant protection measures etc. Physical and chemical analysis of the experimental soil shown in Table (1).

Table (1): Analysis of orchard experimental soil.

Physical properties	Sand	Silt	Clay	$CaCo_3$%	O.M%	Texture
	89.60	5.85	4.55	3.10	0.07	Sandy
Chemical composition	pHe	EC dSm-1	N%	P ppm	K ppm	SO_4 meq/L
	8.70	1.20	0.05	0.80	185.0	3.90
	Na meq/L	K meq/L	Ca meq/L	Mg meq/L	Cl meq/L	Hco_3 meq/L
	0.54	0.37	8.62	3.28	6.00	3.00

To improve productivity of mango cvs Alphonso, multi-micronutrient i.e., boron (B) as borost 15% liquid, zinc (Zn) as microgreen chelat zinc 15% and iron (Fe) as strong chelat iron 12% (100 ppm B, 200 ppm Zn and 250 ppm Fe**)** and two levels of spermine (Spm) "molecular formula" (0.05 and 0.1 mM/Lit) were sprayed once individually alphonse mango tree (27 tree) with (3 tree) control (water spray) at 7 cm long grown panicles, during full bloom and at initial fruit set stages in early morning, during each season. All treatments were applied to run off by using compression sprayers (5L solution / tree) at the previously mentioned times. Wetting agent Tween 20 (1%) was added to all treatments to reduce the surface tension and increase the contact angle of sprayed droplets.

Treatments:

The details of the treatment composition were as follow:

1- Control (water spray)

2- Spraying multi-micronutrient (100 ppm B, 200 ppm Zn and 250 ppm Fe**)** one spray was done at 7 cm long grown panicles, the full bloom or initial fruit set stages.

3- Spraying 0.05 mM/Lit (Spm) one spray was done (spray was carried out once) at 7 cm long grown panicles, the full bloom or initial fruit set stage.

4- Spraying 0.1 mM/Lit (Spm) one spray was done (spray was carried out once) at 7 cm long grown panicles, the full bloom or initial fruit set stage.

Experimental design:

Selected mango trees (30 bearing trees) of each cultivar were alike in growth and set as a Randomized Complete Block Design (RCBD) with three treatments, and three replicates (one tree per replicate), at three application time, beside three trees as a control for each cultivar.

Data were recorded for the following parameters:

Leaf micronutrient content:

The leaf sampling procedure as described by **Parkinson and Allen (1975)**. Iron, Zinc and Boron were determined by using the Atomic Absorption Spectrophotometer.

Productivity:

Fruit set and drop percentage.

Ten shoots one-year-old per each-tree (replicate) were selected and tagged at random, total number of flowers per panicle was counted at full bloom and fruit set was counted two week after full bloom stage. The number of dropped fruits were counted at the pea stage (15 days after fruit set), marble stage (30 days after fruit set) and 15 days before the maturity stage (45 days after fruit set) and calculated as percentages based on set fruits. Percent fruit set (FS %) and fruit drop (FD %)

Fruit number per tree.

At harvest time number of fruits per tree was recorded for each treatment.

Fruit yield (Kg/tree).

The total yield per tree (kg) was obtained at harvest time, when the shoulders of the fruit were swelled out, fruits were picked from all treated trees on 9th and 5th July 2017 and 2018 seasons, respectively, fruits per tree were counted and weighted to estimate the yield/tree (kg).

Fruit quality:

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:

All data collected were subjected to statistical analysis of variance (ANOVA) and significant differences among means were determined according to **(Snedecor and Cochran, 1972)**. In addition significant difference among means were distinguished according to the Duncan's, multiple test range **(Duncan, 1955)** whereas, capital and small letters were used for differentiating the values of specific and interaction effects of investigated factors, respectively.

RESULTS AND DISCUSSION

Leaf micronutrient content (mg/100g) of Alphonso mango cvs:

The content of Percentages of Zn, Fe and B in the leaves was significantly varied among the application of multi-micronutrient or spermine and the control treatment (Table 2). The highest leaf iron content (301.00 and 311.66 mg/100g), respectively in both seasons was obtained at 7cm long grown panicles stage with multi-micronutrient treatment, while, The highest leaf zinc content (50.00 and 53.33 mg/100g), respectively in both seasons was obtained at full bloom stage with multi-micronutrient treatment. Whereas, the highest leaf boron content (67.16 and 68.25 mg/100g), respectively in both seasons was obtained at 7cm long grown panicles with the above treatment. these results were in agreement with those obtained by **Sankar *et al.* (2013)**, **Kumar *et al.* (2017)** and **Zagzog and Gad (2017)** they found that spraying Zebda and Ewasy mango trees with Nano-zinc at 1g/l before flowering is desirable for improving mineral contents of leaf.

Similar studies on citrus, **Hanafy Ahmed *et al.* (2012)**, **Khan *et al*. (2012)** ,**Sarrwy *et al.* (2012)** and **Salama (2015)** showed that foliar spray of algae extract and/or combined with zinc sulfate enhanced leaf mineral content of orange tree cv. Valencia.

Also, on guava**, Lal *et al.* (2000)** they reported that the foliar spray of ZnSO4 at 4g per plant per year significantly increased Zn content of leaves in guava cv. Allahabad Safeda.

Table (2): Mean values of some treatments applied at various spraying dates on leaf iron, zinc and boron content (mg/100g) of mango cvs Alphonso during 2017 and 2018 growing seasons.

Treatments (A)	Spraying date (B)	leaf iron content (mg/100g)		leaf zinc content (mg/100g		leaf boron content (mg/100g)	
		2017	2018	2017	2018	2017	2018
Untreated (Control)	T1	215.00^{D}	220.00^{D}	13.33^{B}	16.66^{B}	62.66^{C}	62.67^{C}
	T2	215.00^{D}	220.00^{D}	13.33^{B}	16.66^{B}	62.66^{C}	62.67^{C}
	T3	215.00^{D}	220.00^{D}	13.33^{B}	16.66^{B}	62.66^{C}	62.67^{C}
mean		215.00^{D}	220.00^{D}	13.33^{B}	16.66^{B}	62.66^{C}	62.67^{C}
Multi-Micronutrient	T1	301.00^{A}	311.66^{A}	50.00^{A}	50.00^{A}	73.33^{A}	83.00^{A}
	T2	287.66^{A}	289.33^{AB}	50.00^{A}	53.33^{A}	72.33^{A}	74.67^{B}
	T3	276.33^{AB}	277.66^{B}	46.66^{A}	46.66^{A}	70.33^{AB}	73.67^{B}
mean		288.33^{A}	292.89^{A}	48.88^{A}	50.00^{A}	72.00^{A}	77.11^{A}
Spermine at 0.05 mM/Lit	T1	240.66^{CD}	241.66^{CD}	16.66^{B}	13.33^{B}	66.00^{BC}	66.00^{C}
	T2	235.33^{CD}	241.66^{CD}	16.66^{B}	13.33^{B}	63.66^{C}	63.33^{C}
	T3	234.00^{CD}	233.00^{CD}	23.33^{B}	20.00^{B}	63.00^{C}	64.66^{C}
mean		236.67^{B}	238.78^{B}	18.88^{B}	15.56^{B}	64.22^{BC}	64.66^{B}
Spermine at 0.1 mM/Lit	T1	236.00^{CD}	236.00^{CD}	10.00^{B}	16.67^{B}	66.67^{BC}	61.33^{C}
	T2	231.67^{CD}	225.67^{CD}	16.67^{B}	20.00^{B}	67.00^{BC}	63.67^{C}
	T3	250.33^{BC}	248.67^{C}	16.67^{B}	13.33^{B}	62.67^{C}	61.67^{C}
mean		239.33^{B}	236.78^{B}	14.44^{B}	16.67^{B}	65.44^{B}	62.22^{B}

Blooming characteristics of Alphonso mango cvs:

Flowering periods (days).

Data presented in Tables (4) show, The statistical analysis indicated a significant difference for the treatments As for the blooming period (days) data preformed that the shortest blooming period (25.00 and 25.66 days), respectively in both seasons was obtained at 7cm long grown panicles stage treated with spermine treatment at 0.05 mM/Lit with insignificant differences between of various treatments spraying dates, Alphonso variety and the spermine treatment at 0.05 mM/Lit.

The highest Sex expression percentage was obtained at full bloom stage with treated with spermine treatment at 0.1 mM/Lit (10.36 %) respectively in both seasons.

The highest fruit set percentage was obtained at 7cm long grown panicles stage treated with spermine treatment at 0.1 mM/Lit (26.69) and (25.03), respectively in both seasons with insignificant differences between of 7cm long grown panicles and initial fruit set stages. This finding is in line with that reported by **Hada *et al.* (2014)**, **Maurya (2004)**, **Singh and Maurya (2004)**, **Nehete *et al.* (2011)**, **Venu *et al*, (2014)**, **Gurjar *et al.* (2015)** they revealed that foliar application of 1% $ZnSO_4$, 1% $FeSO_4$ and 0.5% borax in combination had influenced flowering at pea stage and marble stage of alphonso mango.

and **Zagzog and Gad (2017)** they found that spraying Zebda and 'Ewasy' mango trees with nano-zinc at 1g/l before flowering improved sex ratio.

Table (3): Mean values of some treatments applied at various spraying dates on flowering periods (days), Sex expression percentage and fruit set percentage of mango cvs Alphonso during 2017 and 2018 growing seasons.

Treatments (A)	Spraying date (B)	flowering periods (days)		Sex expression percentage		fruit set percentage	
		2017	2018	2017	2018	2017	2018
Untreated (Control)	T1	26.66c	26.66cde	7.15B	7.29B	13.43C	13.52c
	T2	26.66c	26.66cde	7.15B	7.29B	13.43C	13.52c
	T3	26.66c	26.66cde	7.15B	7.29B	13.43C	13.52c
mean		26.66c	26.66cde	7.15B	7.29B	13.43B	13.52B
Multi-Micronutrient	T1	26.33c	26.00de	9.39A	9.17AB	23.80AB	22.86AB
	T2	25.33c	26.33de	10.13A	10.06A	19.70BC	18.02ABC
	T3	27.00c	28.00abcde	10.01A	10.14A	15.35C	14.98BC
mean		26.22C	26.77BC	9.85A	9.79A	19.61A	18.62A
Spermine at0.05 mM/Lit	T1	25.00c	25.66e	9.72A	9.17AB	17.67BC	16.87ABC
	T2	26.33c	26.00de	10.51A	10.09A	20.09ABC	18.39ABC
	T3	26.66c	26.00de	9.86A	10.82A	16.66BC	15.58BC
mean		26.00C	25.88C	10.03A	10.03A	18.14A	16.94A
Spermine at0.1 mM/Lit	T1	24.33c	27.33bcde	9.05A	8.85AB	26.69A	25.03A
	T2	26.00c	27.33bcde	10.16A	10.13A	17.04BC	16.94ABC
	T3	25.66c	27.00cde	10.36A	9.98A	15.41C	15.41BC
mean		25.33C	27.22ABC	9.86A	9.66A	19.71A	19.12A

Fruiting of Alphonso mango cvs:

Data presented in Tables (4 and 5) showed that fruit drop (%) at the pea stage, marble stage and 15 days before the maturity stage, fruit number/tree and fruit yield (Kg/tree) as affected by some treatments applied at various spraying during 2017 and 2018 growing seasons.

The statistical analysis indicated a significant difference for different treatments. The lowest fruit drop percentage at the pea stage was obtained at various treatments spraying dates with Alphonso variety treated with water spray (control) in both seasons with insignificant differences between them. Whereas, the lowest fruit drop percentage at the marble stage (46.50 and 54.76 %), respectively in both seasons was obtained at beginning bloom stage treated with multi-micronutrient and spermine at 0.05 mM/Lit treatments in the first season. With respect to the beneficial effect of using combine zinc, iron and boron on mango fruiting, these results were coincide with those obtained by **Gurjar *et al.* (2015)** and **Singh *et al.* (2017)** they found that significantly maximum numbers of fruits per tree and fruit yield were recorded under the treatment at 1%

spray of multi micronutrient Grade-IV of mango var. Amrapali.

The results of spraying dates and the different treatments were in harmony with the previous findings as regards the general effects of these factors. While, the highest fruit number/tree was obtained at the initial fruit set stage (135.66) in the second season treated with multi-micronutrient treatment.

While, the highest fruit yield (Kg/tree) was obtained at beginning bloom stage (16.13 and 21.16) in the both season treated with Spermine at 0.05 mM/Lit.

Similar studies of using combine zinc, iron and boron on citrus fruiting, **Sajid *et al.* (2010),** Khan ***et al*. (2012)**, **Baghdady *et al.* (2014)**, **Venu *et al*, (2014)** , **Ilyas *et al.* (2015)** and **Gurung *et al.* (2016)** they concluded that foliar application of GA3 at the rate of 15 ppm along with zinc at 0.5% and boron at 0.1% enhancing the fruit yield of Darjeeling mandarin.

Also, similar studies of using combine zinc, iron and boron on guava fruiting, **Hada *et al.* (2014)** and **Kumar *et al.* (2015)** they reported that the foliar fertilization of Pant Prabhat guava showed an increasing trend towards yield kg/tree with 0.01% Zn two weeks after fruit set while it showed a trend towards decreasing fruit drop with 0.03% Zn two weeks after fruit set.

Several authors confirmed the beneficial effect of using combine zinc, iron and boron on fruiting, **Sayyad-Amin *et al.* (2015)** found that the most yield of olive was seen in foliar spray of zinc sulphate at 2000 mg l-1 and boric at 2000 mg l-1 alone, respectively.

Concerning the beneficial effect of using polyamines on mango fruiting, these results were coincide with those obtained by **Golla (2014)**, **Krishna *et al.* (2017)** and **Subbaiah *et al.* (2017)** Maximum number of fruits set per each panicle was observed with paclobutrazol at 4 ml m-2 and spermidine at 0.02 mM in Banganpalli mango.

Several authors confirmed the beneficial effect of using polyamines on fruiting, **Marzouk and Kassem (2010)** found that pre-harvest foliar sprays of putrescine on Navel orange trees decreased pre-harvest fruit drop. Likewise, **Kassem *et al.* (2011)** mentioned that foliar sprays of 10 mM putrescine on jujube trees, significantly increased fruit retention and yield of Jujube trees.

Table (4): Mean values of some treatments applied at various spraying dates on Fruit drop percentage at the pea stage, Fruit drop percentage at the marble stage and Fruit drop percentage at 15 days before the maturity stage of mango cvs Alphonso during 2017 and 2018 growing seasons.

Treatments (A)	Spraying date (B)	Fruit drop percentage at the pea stage.		Fruit drop percentage at the marble stage		Fruit drop percentage at 15 days before the maturity stage	
		2017	2018	2017	2018	2017	2018
Untreated (Control)	T1	29.77^{F}	30.55^{A}	58.26^{C}	67.56^{AB}	79.63^{B}	69.86^{C}
	T2	29.77^{F}	30.55^{A}	58.26^{C}	67.56^{AB}	79.63^{B}	69.86^{C}
	T3	29.77^{F}	30.55^{A}	58.26^{C}	67.56^{AB}	79.63^{B}	69.86^{C}
mean		29.77^{C}	30.55^{B}	58.26^{B}	67.56^{A}	79.63^{AB}	69.86^{B}
Multi-Micronutrient	T1	33.10^{EF}	30.95^{A}	46.50^{D}	54.76^{B}	72.13^{CD}	75.87^{BC}
	T2	67.14^{A}	48.91^{A}	70.00^{AB}	75.07^{AB}	79.90^{AB}	86.05^{AB}
	T3	53.30^{B}	50.65^{A}	67.46^{AB}	72.55^{AB}	77.80^{BC}	80.08^{ABC}
mean		51.18B^{A}	43.50^{A}	61.32^{B}	67.46^{A}	76.61^{B}	80.67^{A}
Spermine at 0.05 mM/Lit	T1	43.30^{BCDE}	43.55^{A}	43.30^{D}	61.58^{AB}	69.85^{D}	79.65^{ABC}
	T2	37.05^{DEF}	33.93^{A}	67.95^{AB}	73.66^{AB}	81.42^{AB}	82.92^{ABC}
	T3	50.60^{BC}	47.73^{A}	73.18^{AB}	75.68^{AB}	84.20^{AB}	84.58^{AB}
mean		43.65^{B}	41.73^{AB}	61.47^{B}	70.30^{A}	78.49^{A}	82.38^{A}
Spermine at 0.1 mM/Lit	T1	47.61^{BCD}	49.84^{A}	74.30^{A}	80.91^{A}	83.60^{AB}	91.52^{A}
	T2	39.45^{CDEF}	34.44^{A}	73.30^{AB}	77.22^{A}	86.56^{A}	87.25^{AB}
	T3	38.86^{CDEF}	37.50^{A}	66.40^{B}	64.78^{AB}	78.00^{BC}	82.20^{ABC}
mean		41.97^{B}	40.59^{AB}	71.33^{A}	74.30^{A}	82.72^{B}	86.99^{A}

Fruit physical characteristics:

Tables 5and 6 revealed that treating the alphonse mango trees with multi-micronutrient or spermine was significantly enhanced fruit quality in terms of increasing weight, height and diameter of fruit, and fruit number/tree compared to the control treatment. the highest fruit weight (g) was obtained at beginning bloom stage (157.66 and 167.95) in the both season treated with Spermine at 0.05 mM/Lit. Whereas, in the second season the highest fruit peel weight (g) was obtained in full bloom stage with Alphonso variety treated with spermine treatment at 0.1 mM/Lit which resulted in (48.86 g). There were insignificant differences between various spraying dates. Whereas, the highest fruit pulp weight (g)was obtained at beginning bloom stage (82.05 and 89.99) in the both season treated with Spermine at 0.05 mM/LitWith respect to the beneficial effect of using combine zinc, iron and boron on fruit physical characteristics of mango, Similar results were proved by **Anees *et al.* (2011)**, **Nehete *et al.* (2011)**, **Gurjar *et al.* (2015)** and **Singh *et al.* (2017)** they found that significantly maximum fruit weight and fruit volume were recorded under the treatment at 1% spray of multi micronutrient Grade-IV of mango var. Amrapali.

Similar studies of using combine zinc, iron and boron on fruit physical characteristics of citrus, **Venu *et al*. (2014)** and **Gurung *et al.* (2016)** they concluded that foliar application of GA3 at the rate of 15 ppm along with zinc (0.5%) and boron (0.1%) improved fruit yield attributes of Darjeeling mandarin.

Also, similar studies of using combine zinc, iron and boron on fruit physical characteristics of guava, **Kumar *et al.* (2015)** they reported that the foliar fertilization of Pant Prabhat guava showed an increasing trend towards fruit weight and volume with 0.03% B two weeks after fruit.

Concerning the beneficial effect of using polyamines on fruit physical characteristics of mango, these results were coincide with those obtained by **Kassem *et al.* (2011)** they mentioned that foliar sprays of 10 mM putrescine on jujube trees, significantly increased fruit volume. In addition, **Golla (2014**) who illustrated that spermidine could able to significantly increase the fruit weight mango cv. Banganpalli

Table (5): Mean values of some treatments applied at various spraying dates on fruit number/tree), fruit yield (Kg/tree) and fruit weight (g)of mango cvs Alphonso during 2017 and 2018 growing seasons.

Treatments (A)	Spraying date (B)	fruit number/tree		fruit yield (Kg/tree)		fruit weight (g)	
		2017	2018	2017	2018	2017	2018
Untreated (Control)	T1	83.00^C	91.33^E	8.69^C	10.29^C	105.40^E	113.13^D
	T2	83.00^C	91.33^E	8.69^C	10.29^C	105.40^E	113.13^D
	T3	83.00^C	91.33^E	8.69^C	10.29^C	105.40^E	113.13^D
mean		83.00^B	91.33^B	8.69^C	10.29^B	105.40^C	113.13^C
Multi-Micronutrient	T1	102.33^B	127.66^ABC	13.12^B	16.84^B	128.46^D	132.00^CD
	T2	97.66^B	114.00^CD	13.56^B	16.40^B	139.38^ABCD	144.25^ABC
	T3	120.33^A	135.66^A	13.01^B	16.92^B	108.22^E	109.67^D
mean		106.77^A	125.77^A	13.23^B	16.72^A	125.35^B	128.64^B
Spermine at 0.05 mM/Lit	T1	102.33^B	126.00^ABCD	16.13^A	21.16^A	157.66^A	167.95^A
	T2	108.66^AB	111.00^D	14.61^AB	15.34^B	135.00^BCD	138.49^BC
	T3	101.33^B	117.33^BCD	15.20^AB	17.99^AB	150.40^ABC	154.40^ABC
mean		104.11^A	118.11^A	15.31^A	18.16^A	147.68^A	153.61^A
Spermine at 0.1 mM/Lit	T1	109.00^AB	132.00^AB	14.42^AB	17.40^AB	132.00^CD	131.46^CD
	T2	103.66^B	115.33^CD	16.07^A	18.29^AB	154.83^AB	157.89^AB
	T3	97.66^B	124.33^ABCD	14.40^AB	18.68^AB	147.53^ABCD	149.55^ABC
mean		103.44^A	123.88^A	14.97^A	18.12^A	144.78^A	146.30^A

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Table (6): Mean values of some treatments applied at various spraying dates on fruit peel weight (g), fruit pulp weight (g) and total soluble solids (TSS) percentage of mango cvs Alphonso during 2017 and 2018 growing seasons.

Treatments (A)	Spraying date (B)	fruit peel weight (g)		fruit pulp weight (g)		total soluble solids (TSS) percentage	
		2017	2018	2017	2018	2017	2018
Untreated (Control)	T1	31.52^D^	33.18^DE^	59.05^B^	61.10^CD^	15.33^D^	15.33^E^
	T2	31.52^D^	33.18^DE^	59.05^B^	61.10^CD^	15.33^D^	15.33^E^
	T3	31.52^D^	33.18^DE^	59.05^B^	61.10^CD^	15.33^D^	15.33^E^
mean		31.52^C^	33.18^C^	59.05^B^	61.10^B^	15.33^C^	15.33^B^
Multi-Micronutrient	T1	40.82^BC^	41.82^ABC^	62.17^B^	63.71^CD^	17.50^BC^	16.73^D^
	T2	37.48^C^	40.02^BCD^	72.01^AB^	72.29^BC^	19.00^A^	19.50^A^
	T3	26.91^D^	30.65^E^	61.02^B^	56.36^D^	17.50^BC^	18.50^B^
mean		35.07^B^	37.49^B^	65.07^B^	64.12^B^	18.00^A^	18.24^A^
Spermine at 0.05 mM/Lit	T1	45.84^A^	45.15^ABC^	82.05^A^	89.99^A^	18.50^AB^	18.50^B^
	T2	38.40^C^	41.21^BC^	70.40^AB^	68.81^ABC^	18.00^ABC^	19.00^AB^
	T3	45.10^AB^	46.48^AB^	70.80^AB^	71.72^BC^	17.83^ABC^	17.40^D^
mean		43.11^A^	44.28^A^	74.41^A^	76.84^A^	18.11^A^	18.30^A^
Spermine at 0.1 mM/Lit	T1	37.31^C^	39.20^BCD^	66.82^B^	66.61^ABC^	17.00^C^	17.50^CD^
	T2	46.16^A^	48.86^A^	80.93^A^	78.60^AB^	17.63^BC^	18.30^BC^
	T3	37.12^C^	38.26^CDE^	81.70^A^	80.31^AB^	16.83^C^	17.30^D^
mean		40.20^A^	42.11^A^	76.48^A^	75.17^A^	17.15^B^	17.70^A^

Fruit chemical characteristics:

Tables 6 and 7 revealed that treating the alphonse mango trees with multi-micronutrient or spermine was significantly enhanced fruit chemical. The highest total soluble solids (TSS) percentage was obtained at full bloom stage (19.00 and 19.50) in the both season treated with the multi-micronutrient treatment. Whereas, the lowest fruit total acidity percentage was obtained in full bloom stage with multi-micronutrient treatment, which resulted in fruit total acidity percentage of 0.40 % in the first season. Whereas, the highest TSS/acid ratio was obtained at full bloom stage (49.37 and 44.12) in the both season treated with the multi-micronutrient treatment. Whereas, the highest ascorbic acid content (V.C mg/100g juice) was obtained at beginning bloom stage (23.05 and 23.33) in the both season treated with the multi-micronutrient treatment. In terms of the beneficial effect of using combine zinc, iron and boron on fruit chemical content of mango, these results are in consistent with those reported by **Anees *et al.* (2011)** they revealed that mango cv. Dusehri trees sprayed with 0.4% FeSO4, 0.8% H3BO3 and 0.8% ZnSO4 showed the maximum total soluble solids, ascorbic acid and non-reducing sugars along with low acidity in comparison to rest of treatments and control.

Similar results were proved by **Baghdady *et al.* (2014)**, **Ilyas *et al.* (2015)** and **Gurung *et al.* (2016)** they concluded that foliar application of GA3 at the rate of 15 ppm along with zinc at 0.5%) and boron at 0.1% improved fruit quality of Darjeeling mandarin.

According to, Ashraf *et al.* (2014) they indicated that application of zinc improves the citrus fruit quality this might be due to involvement of zinc in photosynthesis, activation of enzyme systems, protein synthesis and carbohydrate translocation. In addition, **Patil *et al.* (2018)** they showed that application of micronutrients especially zinc, copper and boron may prove to be an effective tool for sustainable fruit production.

Concerning the beneficial effect of using polyamines on fruit chemical content of mango**, Bioniel and Protacio (2002), Malik and Singh (2006)** and, **Ayad *et al.* (2011)** they illustrated that, the most effective treatments on increased picual olive fruit quality was those of putrescine at 44 ppm. Also, **Raeisi *et al.* (2013)** indicated that the effect of spermidine on titratable acidity, total soluble solids and flavor index (TSS/acid ratio) was significant of Valencia orange var Olinda. As well as, **Pereira *et al.* (2013)** showed that Delta Valencia oranges grown in the dry climate has excellent quality (total soluble solids, titratable acidity, and TSS/acid ratio and ascorbic acid).

The results of interaction of various treatments spraying dates, and the different

Table (7): Mean values of some treatments applied at various spraying dates on total acidity percentage, TSS/acid ratio and ascorbic acid content (V.C mg/100g juice)of mango cvs Alphonso during 2017 and 2018 growing seasons.

Treatments (A)	Spraying date (B)	total acidity percentage		TSS/acid ratio		ascorbic acid content (V.C mg/100g juice)	
		2017	2018	2017	2018	2017	2018
Untreated (Control)	T1	0.80^{A}	0.79^{A}	18.96^{D}	19.65^{E}	19.16^{B}	19.71^{A}
	T2	0.80^{A}	0.79^{A}	18.96^{D}	19.65^{E}	19.16^{B}	19.71^{A}
	T3	0.80^{A}	0.79^{A}	18.96^{D}	19.65^{E}	19.16^{B}	19.71^{A}
mean		0.80^{A}	0.79^{A}	18.96^{C}	19.65^{B}	19.16^{C}	19.71^{A}
Multi-Micronutrient	T1	0.61^{BC}	0.68^{B}	29.01^{CD}	24.48^{DE}	23.05^{A}	23.33^{A}
	T2	0.40^{E}	0.45^{E}	49.37^{A}	44.12^{A}	21.94^{AB}	21.66^{A}
	T3	0.57^{BCD}	0.47^{DE}	30.74^{BCD}	38.95^{AB}	20.83^{AB}	20.83^{A}
mean		0.52^{C}	0.53^{B}	36.37^{A}	35.85^{A}	21.94^{AB}	21.94^{A}
Spermine at 0.05 mM/Lit	T1	0.44^{DE}	0.55^{CD}	42.44^{AB}	35.55^{BC}	23.05^{A}	21.10^{A}
	T2	0.50^{CDE}	0.44^{E}	37.31^{ABC}	44.77^{A}	21.38^{AB}	21.94^{A}
	T3	0.53^{BCDE}	0.59^{BC}	35.25^{BC}	29.94^{CD}	22.50^{AB}	22.49^{A}
mean		0.49^{C}	0.53^{B}	38.33^{A}	36.75^{A}	22.31^{A}	21.84^{A}
Spermine at	T1	0.67^{AB}	0.62^{BC}	25.79^{CD}	28.17^{CD}	20.38^{AB}	21.94^{A}
	T2	0.58^{BCD}	0.57^{C}	31.58^{BCD}	33.48^{BC}	19.72^{AB}	20.27^{A}

0.1 mM/Lit	T3	0.65 ABC	0.63 BC	26.02 CD	28.13 CD	20.83 AB	19.72 A
mean		0.63 B	0.61 B	27.80 B	29.93 A	20.31 BC	20.64 A

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