Fruit Retention, Yield and Postharvest Fruit Quality of Mango in Relation to: II. Time and Number of Potassium Nitrate, Zinc and Boron Foliar Sprays

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ABSTRACT

The present investigation was conducted during 2002 and 2003 growing seasons in order to evaluate the effect of three application times (before bloom, at bloom and at pea stage) and number (1, 2 or 3) of potassium nitrate, zinc and boron sprays on Hindi-Be-Senara mango trees. Shoot length and chlorophyll content were increased by Zn and KNO_3 sprays. Spraying KNO_3 1, 2 or 3 times significantly increased leaf N, K, Ca and B contents. Spraying Zn increased leaf K, Ca, Mg and Zn contents while B sprays increased leaf K, Ca, Mg and B leaf contents. However, Zn and B sprays decreased leaf P content whereas, leaf Fe content was decreased by Zn sprays only. In general two or three sprays of Zn or B increased fruit set, fruit retention and yield and decreased fruit drop percent. However, two and three sprays did not differ significantly. Fruit retention, drop, weight, length, diameter, yield and V.C contents were affected by KNO_3 treatments. However, acidity was not affected by any treatment.

INTRODUCTION

Mango occupies the fifth planted area among fruit species produced in Egypt. In the meantime, it became a fairly common commodity for the most consumers in outlands. This supports the idea of encouraging the marketability of the Egyptian mango to foreign countries such as Europe and the Far East. Zebda and Hindi are of the promising mango varieties grown in Egypt (Riad, 1997). The growth and productivity of the mango tree is known to relay mostly on its nutritional status as well as the environmental and hormonal factors (Kulkarni, 2004). Interrelations between growth, development and productivity of mango tree and the macro and micro nutrient content in the leaves at the vegetative and reproductive phase is reported (Guzman-Estrada, 2000). Foliar application of most nutrients is recommended to increase mango trees productivity. The effect of applying fertilizers containing potassium, zinc and/or boron as foliar sprays were reported in many investigations. Potassium was found to enhance flowering (Sergent *et al.*, 1997 and Ataide and Jose, 2000), tree growth (Shongwe and Roberts-Nkrumah, 1997 and Sergent *et al.*, 2000), fruit retention, yield and fruit quality of mango (Bhuyan and Irabagon, 1992, Sharma *et al.*, 1990, Oosthuyse, 1993, Oosthuyse, 1997, Ataide and Jose, 2000). Zinc is most important in the flowering and fruit set and the effect of foliar application of zinc on zinc uptake, yield and fruit quality of mango was investigated (Bahadur *et al.*, 1998). In addition, determining the time and number of sprays of these elements is very important to obtain their best effect on tree growth and productivity. Accordingly, the present study was aimed to evaluate time and number of potassium nitrate, zinc and boron foliar sprays on

fruit retention, growth, yield and fruit quality of Hindi-Be-Senara mango trees grown in a calcareous soil.

MATERIALS AND METHODS

The present study was carried out during the 2002 and 2003 growing seasons on 28 years old Hindi-Be-Senara trees (*Mangifera indica*, L.) grown in Abou -El-Matameer region near Alexandria. The soil was sandy clay calcareous with pH 7.76-7.82, $CaCO_3$ of 31% and water table level of about 130 cm from the soil surface. Trees were planted at 6x7 m apart irrigated with Nile water every 15 days. The orchard was fertilized with organic manure and calcium superphosphate at the rate of 20 cubic meters and 150 kg per feddan, respectively, in December every year. Orchard was also fertilized by ammonium nitrate at the rate of 350 kg/fed. at two equal doses (mid-March and Mid-June). Ten foliar spray treatments included spraying with water only (control), 20 g/l potassium nitrate (46.2%K_2O, 13.5% N), 0.5 g/l amino acid chelated zinc (12% Zn) and 0.7 g/l borax (17.5% B) and were arranged in a randomized complete block design. Each treatment included three replicates with one tree for each replicate surrounded with guard trees. The three nutrients were separately applied once, twice or three times in the following spraying dates: before bloom (BB, mid-March), at bloom (AB, mid-April) and at pea stage (APS, mid-May). Water was sprayed on the small panicles of control trees. Each tree received approximately 8 liters of the spray solution and the surfactant Biofilm (30 cm/100L water) produced by Biotech-Egypt was added to the sprayed solutions.

In order to study the effect of the different treatments on tree growth, five main branches were tagged on the different sides of each tree in February and the length of spring non-fruiting shoots per branch was measured in September of both seasons. In both seasons, the number of fruits on each panicle of the tagged branches was recorded after fruit set (May) and after June drop (July). Fruit set and fruit retention were calculated as follows: Fruit set = average fruits number per panicle
Fruit retention = number of remained fruits per tree after June drop / number of fruits per tree after fruit set.

Yield as kg and number of fruits per tree was recorded at harvest time (mid-September) of both seasons. Leaf samples were collected at random from the medium parts of the non-fruiting shoots on the previous tagged branches in mid-September of both seasons in order to determine leaf N, P, K, Ca, Mg, Fe, Zn, Mn, B and chlorophyll contents. Each leaf sample consisted of 30 leaves for each replicate. Leaves were thoroughly washed with tap water, rinsed twice with distilled water, dried to a constant weight in an air drying oven at 70 °C and then they were grounded and digested with H_2O_2 and H_2SO_4 according to the method of Evinhauis and Dewaard (1980). Fe, Zn, Mn and B were determined

using an atomic absorption spectrophotometer 305B. Leaf chlorophyll as mg/100 g fresh weight was measured according to Moran and Porath (1980).

In order to determine fruit quality characters, twenty fruits were randomly sampled once at harvest time from each tree in both seasons. In each sample fruit weight, diameter, and length were measured. Also, juice TSS, V.C and acidity contents were estimated. The data were statistically analyzed according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Shoot length

The data presented in Tables (1 and 2) showed that one, two or three sprays of KNO_3 significantly increased shoot length in both seasons when compared with the control. However, no significant differences between one and two potassium sprays were obtained in the first season, whereas, in the second season spraying KNO_3 three times had a high effect than one spray. An increase in growth of mango trees as a result of K sprays were reported (Symal and Mishra, 1989 and Sergent *et al.*, 2000).In addition, spraying Zn two (AB +APS) and three (BB + AB + APS) times significantly increased shoot length in both seasons as compared with the water sprayed control. These results are in line with those of Abo-Taleb *et al.* (1998). However, spraying B three times (BB + AB + AS) in both seasons and two times in first season increased shoot length as compared with the control (Tables 1 and 2). Similar results were obtained by Delcheva and Makariev (1982) and Marzouk *et al.* (2003).

Leaf chlorophyll

The data of both seasons revealed that all potassium nitrate sprays significantly increased leaf chlorophyll content as compared with the control. However, spraying potassium nitrate three times (BB + AB + APS) had a higher effect than one spray in the first season and one and two sprays in the second season. It might be attributed to that the KNO_3 increased leaf N content. In addition, zinc sprayed once in the first season only, two and three times in both seasons had a significant effect on leaf chlorophyll content as compared with the control. However, B did not affect leaf chlorophyll content in both seasons (Tables1 and 2). These results are in line with those obtained by Qin *et al.* (1993), Nakhlla (1998) working on orange and Supriya and Bhattacharyya (1993) working on lemon. They reported that Zn sprays increased leaf chlorophyll content.

Leaf mineral content

Regarding nitrogen content, the results in tables 1 and 2 showed that all potassium nitrate sprays significantly increased the concentration of this element in the leaves in both seasons as compared with the control. This increase might be attributed to that potassium nitrate contained 13.5% N. In

addition no differences between potassium nitrate sprays were obtained. Moreover, leaf phosphorous content was significantly decreased by two and three Zn sprays in both seasons as compared with the control (Tables 1 and 2). This might be attributed to the antagonistic reaction between Zn and P (Rasoulisadaghni *et al.*, 2002). Also, two (first season only) and three (first and second seasons) boron sprays gave a significant lower phosphorous leaf content than the control. However, potassium did not significantly affect leaf P content (Tables 1 and 2).

Moreover, the data in Tables (1 and 2) showed that all potassium nitrate sprays significantly increased leaf K content in both seasons. Similar results were obtained by Abd El-Al *et al.* (1994). Additionally, leaf K content was significantly increased by spraying Zn two (both seasons) and three (second season only) times comparing with the control. Moreover, three boron sprays (BB + AB + APS) in both seasons and two sprays in the first season increased leaf K content in both seasons as compared with the control. Wojcik (1998) found that the leaf K content was increased by after full bloom B sprays.

Leaf Ca content was higher than the control by two or three KNO_3 sprays in both seasons. In addition, spraying Zn or B two and three times significantly increased leaf Ca content in both seasons as compared with the water sprayed control (Tables 1 and 2). However, no significant differences between two and three sprays of these elements were obtained. Boron encourages the uptake and mobility of Ca (Atkinson *et al.*, 1980 and Wojcik, 1998). However, leaf Mg content was significantly increased by all Zn and B sprays in both seasons whereas, KNO_3 had no effect on leaf Mg content. In addition, spraying Zn three times gave a higher Mg content than one spray in the second season only. Marzouk *et al.*(2003) found that spraying B once after full bloom increased leaf Mg content. The results obtained in Tables (1 and 2) showed that leaf Fe content was significantly decreased by all Zn sprays in both seasons as compared with the control. On the other hand, one and three foliar sprays of KNO_3 and three sprays of B significantly increased leaf iron content in the second season only. Marzouk *et al.*(2003) found no effect on leaf Fe content by Zn and B sprays.

The data of both seasons revealed that only zinc sprays significantly affected leaf Zn content as compared with the control (Tables 1 and 2). These results are in line with those of EL-Gazzar *et al.* (1979). They found that spraying orange trees in May with chelated Zn markedly increased leaf zinc content. Also, Taha *et al.* (1979) reported that the zinc applied in June was absorbed more rapidly than that applied in March or September. Nakhlla (1998) stated that monthly zinc sprays increased leaf zinc content of Navel orange. Additionally, manganese content was not affected by any of the treatments in both seasons. Boron was significantly increased by all B sprays

in both seasons and by all KNO_3 sprays in the second season only comparing with the control (Tables 1 and 2). Similar results were obtained by Marzouk *et al.*(2003).

Fruit set and retention

The data in Table (3) showed that both KNO_3 and Zn sprayed two (BB + AB) or three times (BB + AB + APS) and all boron sprays significantly increased fruit set and fruit retention in both seasons when compared with the control. The increase in fruit set and retention of mango trees as a results of potassium foliar sprays during flowering and just before fruit drop is evidenced in many investigations (Oosthuyse, 1993; Oosthuyse, 1997; Sergent *et al.*, 1997 and Ataide and Jose, 2000). In addition, boron needed for reproductive growth in many crops is more than that needed for vegetative one. It stimulates the transport of sugars throughout the plant, it affects auxin metabolism (Lovah, 1985) and it is also required for calcium uptake (Atkinson *et al.*, 1980). Accordingly, boron plays an important role in increasing fruit set and retention. Also, Zn increased the auxin content in orange (Nakhlla, 1998). Additionally, the deficiency of boron and zinc may cause an increase in the misshapen and abortion percentage of fruit. This explains their importance for fruit set and retention.

Fruit drop

The data presented in Table (3) indicated that all treatments, except one spray of KNO_3 BB, decreased fruit drop percent in both seasons comparing with the control. Similar findings were obtained by Bhuyan and Irabagon (1992) working on Carabao mango.

Yield

The results of both seasons revealed that two and three sprays of KNO_3 or Zn and all B sprays increased the yield significantly (Table 3). These results are in line with those of Sharma *et al.* (1990), Oosthuyse (1993), Sergent *et al.* (1997) and Bahadur *et al.*(1998) working on mango. The Hindi-Be-Senara mango is polyembryonic. Nunez-Elisa (1987) reported that polyembryonic mango gave higher yield than monoembryonic one as a result of KNO_3 foliar sprays. Moreover, from the above data the repeated sprays of the chleated zinc were most effective than the single one. Swietlik (2002) reported that zinc sprays applied before anthesis might be most beneficial in terms of fruit yield in citrus. In addition, the yield expressed as number of fruits was significantly increased in both seasons by all treatments except a single spray of Zn or KNO_3 (Table 3). The effect of KNO_3 on number of fruits per tree was reported (Osman *et al.*, 1990). Ataide and Jose (2000) indicated a high number of fruits per tree in Tommy Atkins mango by KNO_3 spraying intervals.

Fruit quality

The data obtained in Table (4) showed that fruit acidity content was not affected by any of the spraying treatments in both seasons. However, vitamin C was significantly increased by all KNO_3 sprays and three B sprays in the second season only. These results agreed with those of El-Otmani *et al.*(2004). The total soluble solids were increased by all treatments, except single Zn spray in both seasons, as compared with the control in both seasons. These results agreed with those of Kumar and Kumar (1989). They found that two sprays of zinc showed a positive effect on the TSS content of mango. Moreover, fruit weight was significantly increased in both seasons by all KNO_3 sprays only, except one spray in the first season. From the previous results, leaf K content was increased by all KNO_3 sprays. A positive significant correlation between leaf K concentration and fruit weight was reported by Taheri and Talaie (2001). The data in Table 4 also showed that fruit length was not affected by any of the Zn sprays whereas, it was significantly increased by all KNO_3 treatments and by spraying B three times (BB + AB + APS) in both seasons. In addition, Zn and B sprays had not significant effect on fruit diameter in both seasons. On the other hand, all KNO_3 treatments, except a single spray in the first season, significantly increased fruit diameter in both seasons (Table 4). Evidence on increasing mango fruit size as a result of potassium sprays is also reported by Singh and Tripathi (1978), Symal and Mishra (1989), Bhuyan and Iragbagon (1992) and Oosthuyse (1993). Also, Wahid-Ali *et al.* (1991) detected high quality characters by spraying boron to guava trees before flowering and at fruit set.

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Table 1. Effect of Zn, B and KNO_3 foliar sprays on leaf mineral and chlorophyll contents and shoot length of Hindi-Be-Sennara mango trees in 2002 season.

Treatment		N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	B (ppm)	Chlorophyll (mg/100 g fresh wt.)	Shoot length (cm)
Control		1.98	0.19	1.80	1.92	0.43	98	21	23	38	242	16.62
Zn	1 spray	2.21	0.19	1.90	2.40	0.53	76	34	23	40	286	20.42
Zn	2 sprays	2.06	0.12	2.06	2.50	0.62	70	36	28	38	296	21.86
Zn	3 sprays	2.20	0.12	1.80	2.52	0.56	80	40	30	40	284	22.86
B	1 spray	2.12	0.18	1.87	2.32	0.58	93	26	26	56	223	20.08
B	2 sprays	1.98	0.15	2.00	2.60	0.60	98	21	25	57	239	21.12
B	3 sprays	2.26	0.14	2.00	2.60	0.62	100	28	26	60	246	21.04
KNO_3	1 spray	2.32	0.20	2.00	2.41	0.50	102	22	23	43	292	22.26
KNO_3	2 sprays	2.36	0.20	2.00	2.58	0.43	100	26	28	38	320	24.08
KNO_3	3 sprays	2.32	0.19	2.06	2.52	0.43	96	26	25	38	346	26.07
$L.S.D_{0.05}$		0.30	0.03	0.18	0.52	0.10	10	11	N.S	12	32	3.88

Table 2. Effect of Zn, B and KNO_3 foliar sprays on leaf mineral and chlorophyll contents and shoot length of Hindi-Be-Sennara mango trees in 2003 season.

Treatment		N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)	B (ppm)	Chlorophyll (mg/100 g fresh wt.)	Shoot length (cm)
Control		2.00	0.16	1.54	1.98	0.40	102	23	22	40	268	18.46
Zn	1 spray	1.93	0.14	1.84	2.12	0.48	88	36	28	36	272	20.24
Zn	2 sprays	1.90	0.12	2.06	2.36	0.52	82	39	30	42	298	21.07
Zn	3 sprays	2.00	0.10	2.00	2.30	0.58	78	43	26	40	306	21.92
B	1 spray	1.90	0.17	1.90	2.06	0.50	98	28	23	58	274	19.21
B	2 sprays	2.06	0.13	1.92	2.36	0.57	100	30	25	60	286	20.06
B	3 sprays	2.12	0.11	2.02	2.42	0.53	112	31	24	63	272	20.82
KNO_3	1 spray	2.27	0.17	2.00	2.13	0.43	118	32	28	52	300	22.08
KNO_3	2 sprays	2.32	0.18	2.12	2.32	0.40	106	30	26	50	340	23.27
KNO_3	3 sprays	2.36	0.17	2.18	2.21	0.44	112	28	30	53	352	25.83
$L.S.D_{0.05}$		0.23	0.04	0.41	0.20	0.08	8	13	N.S	10	25	2.13

Table 3. Effect of Zn, B and KNO_3 foliar sprays on fruit set, fruit retention, fruit drop, fruit number and yield of Hindi-Be-Sennara mango trees in 2002 and 2003 seasons.

Treatment		2002 season						2003 season					
		Fruit set	Fruit retention (%)	Fruit drop (%)	Fruit number /tree	Yield (kg/tree)	Yield increment (%)	Fruit set	Fruit retention (%)	Fruit drop (%)	Fruit number /tree	Yield (kg/tree)	Yield increment (%)
Control		8	10	90	282	61	0.0	11	9	91	318	67	0.0
Zn	1 spray	11	16	84	321	72	18	12	12	82	356	76	13
Zn	2 sprays	14	17	83	350	76	25	15	16	84	386	86	28
Zn	3 sprays	18	18	82	370	84	38	16	17	83	406	89	33
B	1 spray	13	17	83	336	75	23	17	17	83	378	82	22
B	2 sprays	13	20	80	366	80	31	17	19	81	400	91	36
B	3 sprays	20	20	80	396	87	43	21	21	79	421	93	39
KNO_3	1 spray	9	13	87	311	72	18	14	12	88	342	79	18
KNO_3	2 sprays	13	18	82	336	80	31	16	16	84	362	86	28
KNO_3	3 sprays	14	17	83	340	82	34	16	15	85	365	87	30
$L.S.D_{0.05}$		5	7	5	48	14		4	5	6	43	13	

Table 4. Effect of Zn, B and KNO_3 foliar sprays on postharvest fruit quality of Hindi-Be-Sennara mango trees in 2002 and 2003 seasons.

Treatment		2002 season						2003 season					
		TSS (%)	Acidity (%)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	V.C content (mg/100 g fresh wt.)	TSS (%)	Acidity (%)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	V.C content (mg/100 g fresh wt.)
Control		15.4	0.32	216	11.32	6.36	14	15.06	0.22	220	11.56	6.62	12
Zn	1 spray	16.2	0.28	221	12.00	6.63	12	15.88	0.21	212	11.60	6.60	14
Zn	2 sprays	16.8	0.30	218	11.72	6.21	17	16.72	0.19	220	12.08	6.21	11
Zn	3 sprays	17.1	0.26	226	12.06	6.72	18	16.84	0.28	218	11.62	6.43	15
B	1 spray	17.0	0.31	222	11.82	6.80	13	16.80	0.22	218	12.21	7.32	13
B	2 sprays	17.8	0.25	218	12.12	6.28	15	17.06	0.26	228	12.00	7.06	14
B	3 sprays	17.8	0.26	220	12.28	7.07	19	17.26	0.30	220	12.42	7.00	17
KNO_3	1 spray	17.8	0.28	228	12.26	7.00	20	17.48	0.23	230	12.52	7.60	16
KNO_3	2 sprays	18.2	0.32	238	12.70	7.16	19	17.62	0.23	238	12.48	7.58	18
KNO_3	3 sprays	19.6	0.31	242	12.71	7.28	21	17.82	0.21	239	12.46	7.72	17
$L.S.D_{0.05}$		1.2	N.S	14	0.86	0.78	N.S	1.6	N.S	9	0.74	0.66	3

الملخص العربى

بقاء الثمار والمحصول وصفات جودة ثمار المانجو وعلاقتهـــا بـــ:
II- الرش الورقى بعدد ومواعيد رش مختلفة بنترات البوتاسيوم والزنك والبورون

حسن على قاسم و هند على مرزوق

قسم الفاكهة – كلية الزراعة (بالشاطبى) -جامعة الأسكندرية

أجريـــت هـــذه الدراسة خلال عامى ٢٠٠٢ ، ٢٠٠٣ بهدف دراسة تأثير عدد مرات رش (١، ٢، ٣ رشة) ومواعيد (قبل الإزهار، عند الإزهار وعند مرحلة وصول الثمار لحجم البسلة) بكل من نترات البوتاسيوم والزنك والبورون على أشجار المانجو صنف هندى بستاره النامية فى أرض جيرية. وكانت النتائج كالآتى:

١- زاد النمو والكلوروفيل بالرش بالزنك ونترات البوتاسيوم.

٢- ســبب الــرش بنــترات البوتاسيوم مرة أو مرتين أو ثلاث مرات زيادة معنوية فى محتوى الأوراق من النيتروجين والبوتاسيوم والكالسيوم والبورون.

٣- ســبب الــرش بالزنك الخلبى والبورون زيادة فى محتوى الأوراق من الكالسيوم والبوتاسيوم والمغنسيوم والبورون ونقص الفوسفور، بينما سبب الرش بالزنك فقط إنخفاض الحديد.

٤- ســبب الرش مرتين أو ثلاث مرات بالزنك ونترات البوتاسيوم وكل رشات البورون زيادة فى العقد وبقاء الثمار والمحصول خلال عامى الدراسة.

٥- ســببت جمــيع معاملات الرش بنترات البوتاسيوم زيادة فى محتوى الثمار من المواد الصلبة الذائبة الكلية ووزن وطــول وقطر الثمار خلال عامى الدراسة ومحتوى فيتامين ج فى العام الثانى فقط ولم تؤثر جميع المعاملات على محتوى الثمار من الحموضة.

٦- ســبب الرش مرتين أو ثلاث مرات بالزنك والبورون زيادة فى المواد الصلبة الذائبة الكلية ولم تؤثر على باقى صفات الجودة.