Effect of Zinc and Iron on Growth and Yield of GrandNain Banana Cultivar in Sandy Soil

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ABSTRACT

A field study was carried out during 2008/2009-2009/2010 in Grand Nain (the plantlets developed from local meristems, superior selected from Grand Nain Banana *cv.*) grown in private orchard at El khtatba, Monofia Governorate, during two successive seasons to determine the Zn and Fe requirements. The plants were received different rates of Zn and Fe fertigation. The rates per plants were ((0.0, 5.4, 10.8 and 21.6 gm/plant) in the form of $ZnSO_4$ and (0.0, 9.0, 18.0, 36.0 gm/plant) actual Fe (EDTA). All considered Zn and Fe rates were applied every month from April till October and were added as solution by fertigation. Results show that, the increasing rates of each fertilizer (Zn and Fe) increased plant height, pseudostem girth, leaves number, leaf area and reduced the number of days taken shooting till flowering. Zn-fertigation had greatest effect on vegetative growth, time to shooting and harvesting. The uppermost Zn level (21.6g./plant) resulted in progressive increase in growth characteristics and yield. Application of (36.0g.Fe/plant) results in a significant increase in growth finger characteristics . Increasing Zn rates raised leaf N, P, K, Zn and Fe. Increasing rate of Fe-fertigation increased leaf N, P, K, Zn and Fe.

Application of 21.6g. Zn/plant and 36.0g.Fe/plant is monthly from April to October recommended for GrandNain banana in sandy soil.

Keyword: Banana fertigation, fertigation by Zn and Fe, Micro-nutrition

INTRODUCTION

Banana (*Musa spp*.) is a tropical plant and was considered as one of the most popular and favorite fruits in the world since, fruits have excellent flavor, nice taste and high nutritional value, in addition to some miscellaneous uses and a number of minor edible products.

In Egypt, banana production was not sufficient to cover the demands of local Egyptian markets, the latest statistics of the ministry of Agriculture in 2009 referred that the area occupied by banana plants in the Delta regions and Nile valley was estimated by 62236 feddans, and generally produced 1122698 tons.

From the botanical view, banana plant was considered as a herbaceous mesophytic plant, with fast growth rate in nursery and field.

Although only minor quantities of micro-nutrients are needed, they are indispensable to the vegetative growth and yield of banana (Twyford, 1967). Very little work has been carried out on trace elements requirements of banana plants. However the importance of these trace elements on vegetative growth and production of banana had been recorded for zinc (Jordine, 1962 and Nason, 1950) and Iron (Ziv, 1954), (Abdel- Kader,1986, Hamam, 1988, Abdel-Kader *et al.*, 1992 , Sallam *et al*.,2002 and Ghanta and Mitra 1993) applied mixture of micro-nutrients as foliar spray (Zn, Cu, B and Mg) beside the common programmer of N, P and K fertilizations applied to Hindy banana plants increased the number of green leaves, improved bunch shooting and greatly increased bunch weight in plants (Moreira *et al.*, 2007). Zinc is absorbed by the roots and quickly transported to the aerial part. It is partially mobile within the plant and its transport occurs passively through transpiration flow (Epstein and Bloom, 2005). Nevertheless, the transport mechanisms of sap in the xylem are subject of considerable debate (Longnecker and Robson, 1993). Zinc is known to have an important role as a metal component of enzymes or as a functional structural or regulatory cofactor of a large enzyme (Werner, 1992). Zinc accelerates auxin synthesis or protects auxin from oxidative destruction (Cakmak, 1988). Zinc deficiency reduced the distance between hands and giving them bunches with a compact appearance (Brown *et al*., 1993 and Borges *et al.*, 2006). Swidan (1972) noticed that the differentiation of inflorescences in banana plants cv. Hindi is positively correlated with the total leaf area per plant.

The objective of this study was to determine the optimum amount of zinc sulfate and iron (EDTA) added by fertigation around the year/plant to obtain high yield, good quality and to reduce the cost of fertilizers of Grand Nain banana plants in the newly reclaimed sandy soil under drip irrigation system.

MATERIALS AND METHODS

This experiment was carried out during two successive seasons of 2008/2009 and 2009/2010 on GrandNain banana cultivar growing in private orchard at El khtatba, Monofia Governorate Egypt. The physical and chemical analysis of sandy soil are presented in Table (1).

Plants were planted at 3.5x3m apart in March 2007. Suckers nearly similar in vigour and growth.

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Table 1. Soil characteristics of the banana plantation at the start of experiment

(a): Physical analysis

Depth cm	**Mechanical analysis %** Course sand %	Fine sand %	Silt %	Clay %	**Bulk Density** gm/cm3	**CaCo3** %	**Textural** class
0-30	56.8	21.7	3.4	14.0	1.38	3.8	Sandy
30-60	56.5	28.6	2.0	10.0	1.41	4	Sandy
60-90	70.8	17.3	2.0	6.0	1.4	3.5	Sandy
Mean	61.63	22.53	2.46	10	1.4	3.76	Sandy

(b): Chemical analysis

Depth	**Soluble ions (meq/100gm.soil)**								**E.C. mmhos/ cm. at 25C^0**
	Cations				**Anions**				
cm	**Ca^{++}**	**Mg^{++}**	**Na^+**	**K^+**	**$CO3^{--}$**	**$Hco3^-$**	**Cl^-**	**So^{--}**	
0-30	0.71	0.38	0.90	0.05	trace	0.35	0.85	0.92	0.66
30-60	0.26	0.06	0.42	0.02	trace	0.20	0.30	0.60	0.52
60-90	0.20	0.10	0.36	0.02	trace	0.20	0.30	0.54	0.40
Mean	0.39	0.18	0.56	0.03	trace	0.25	0.483	0.686	0.526

As such, the tested plants of banana *cv*. have a semi-long pseudostem. For this purpose, only three new suckers per mat (stool) were selected from the second ratoon plants.The suckers of tested ratoon were nearly similar in height, growth and vigour. The experimental soil was classed as a sandy in texture and deficiency in fertility according to the mechanical and chemical analyses of samples (Table 1) desempled by (Jackson, 1958).

Accordingly, the experiment included 16 treatments each treatment comprised 3 replicates distributed in Randomized Complete Block Design (R.C.B.D).

The selected plants received all agricultural practices usually applied in banana plantation except Zn and Fe fertigation.

A factorial experiment with different rates of Zn and Fe and their combinations, four ZnSO4 fertigation rates (0.0, 5.4, 10.8 and 21.6 gm/plant) and Fe (EDTA) (0.0, 9.0, 18.0 and 36gm/plant) were added every month during the period from April till October in both seasons.

The following parameters were used to evaluate the tested treatments:

1-Vegetative growth:

Morphological measurements were done at bunch shooting via the following parameters: Pseudostem height (m); pseudostem circumference (m), number of green leaves / plant and total green leaf area (m^2) which was calculated according to (Ahmed and Morsy, 1999) by using the formula:

TL= 0.67(I +w) + 107.15

Where: T= total, L= leaf, I = length, w= width.

2-Flowering:

The periods from sucker emergence to bunch shooting and from sucker emergence to bunch harvesting were calculated.

3-Bunch characteristics:

At time of harvesting the bunch weight in Kg., average number of hands per bunch, average number of fingers per bunch, hand weight (g), average number of fingers/hand and weight of finger (g) were determined.

4-Leaf mineral content:

At bunch shooting, leaf samples were taken from the third upper most leaf in the succession of leaves from the plant top. Samples of fresh leaves were dried at 70 C^0 to a constant weight, then ground and subjected to the following determinations:

a) Total nitrogen was determined by using the microkjeldahl method as described by Pregl (1945)

b) Phosphorus was determined colorimetrically according to A.O.A.C. method (1985).

c) Potassium was determined using a flame photometer according to the method mentioned by Brown & Lilleland (1946).

d) Zinc and iron were determined spectrophotometrically using an Atomic absorption according to Brandifeld and Spincer (1965)

N, P and K were estimated as percentage of dry weight. Other elements Zn and Fe were estimated as ppm/g dry weight.

The obtained data were subjected to analysis of variance for factorial design in randomized complete blocks with three replicates in each treatment (Snedecor& Cochran, 1980). The means were compared by using the method of new least significant differences (New L.S.D. at o.05) described by Waller& Duncan (1969).

RESULTS AND DISCUSSION

Data in Table (2) show that, vegetative growth (pseudostem height, pseudostem circumference, number of green leaves and leaf area) of the GrandNain banana at bunch shooting stage in both seasons significantly varied due to Zn- fertigation rates (0.0, 5.4, 10.8 and 21.6 g/plant) and Fe- fertigation rates (0.0, 9.0, 18.0 and 36.0 g/plant) and their combinations. The pseudostem height, circumference, number of green leaves/plant and leaf area were significantly increased by increasing Zn- fertigation rate up to 21.6g/plant and this was true in the two seasons. Results of the effect of different Zn rates on vegetative growth of banana were in agreement with (Jordine, 1962), (Abdel- Kader,1986 and Abdel-Kader *et al.*, 1992)) and Moreira *et al.*, 2007).

The data clarified obvious effect of Fe- fertigation on vegetative growth of the tested GrandNain banana plants. Vegetative growth was significantly increased by increasing Fe- fertigation rate up to 36.0g/plant.

As for the previous available papers concerning the effect of Fe- fertigation on vegetative growth results of (Ziv, 1954), (Jordine, 1962) and (Abdel- Kader,1986, Hamam, 1988 and Abdel-Kader *et al.*, 1992) working on banana are in harmony and support the obtained herein results.

The effect of interactions between Zn and Fe fertigation on vegetative growth are presented in Table (2). It is clear that, the interaction (Zn x Fe) were statistically significant, which indicate a high degree of interdependence between the studied nutrients. This was apparent with all considered vegetative growth parameters. The highest values for vegetative growth in

Table 2. Effect of Zn and Fe fertigation on vegetative growth of GrandNain banana plants during 2008/2009and2009/-2010

Zn- fertigation rates gm./ plant	First season					Second season				
	Fe-fertigation rates gm./plant									
	0.0	9.0	18.0	36.0	Av.	0.0	9.0	18.0	36.0	Av.
Pseudostem height (m)										
0.0	2.67	2.80	2.85	2.95	2.82	2.70	2.74	2.84	2.92	2.8
5.4	3.00	3.10	3.15	3.17	3.10	2.75	2.87	2.92	2.98	2.88
10.8	3.00	3.10	3.15	3.20	3.11	2.89	2.93	2.99	3.18	2.99
21.6	3.10	3.20	3.25	3.30	3.21	3.00	3.10	3.19	3.20	3.12
Av.	2.94	3.05	3.1	3.15		2.83	2.91	2.98	3.07	
New L.S.D at 0.05	Zn 0.053	Fe 0.053	Interaction 0.105			Zn 0.043	Fe 0.043	Interaction 0.066		
Pseudostem circumference (m)										
0.0	0.70	0.78	0.80	0.84	0.78	0.68	0.76	0.81	0.83	0.77
5.4	0.72	0.76	0.77	0.82	0.77	0.76	0.77	0.79	0.83	0.79
10.8	0.75	0.79	0.81	0.82	0.79	0.78	0.80	0.82	0.85	0.81
21.6	0.81	0.84	0.85	0.87	0.84	0.82	0.86	0.87	0.88	0.86
Av.	0.74	0.79	0.81	0.84		0.76	0.80	0.82	0.85	
New L.S.D at 0.05	Zn 0.024	Fe 0.024	Interaction 0.047			Zn 0.017	Fe 0.017	Interaction 0.033		
Number of green leaves/ plant										
0.0	11.0	12.0	13.0	13.0	12.25	11.3	12.0	13.0	13.0	12.32
5.4	12.0	13.0	13.0	13.0	12.75	12.0	13.0	13.0	13.0	12.75
10.8	13.0	13.0	13.0	13.0	13.00	13.0	13.3	13.3	13.3	13.22
21.6	13.0	13.0	13.33	13.67	13.25	13.3	13.4	13.5	13.5	13.42
Av.	12.25	12.75	13.08	13.17		12.40	12.92	13.20	13.20	
New L.S.D at 0.05	Zn 0.737	Fe 0.737	Interaction 1.473			Zn 0.673	Fe 0.673	Interaction 1.346		
Leaf area/plant (m^2)										
0.0	13.685	15.640	16.184	16.984	15.623	14.05	15.57	16.09	17.09	15.70
5.4	16.320	16.617	17.636	19.225	17.449	16.43	16.52	17.74	19.15	17.46
10.8	16.320	17.340	17.425	19.127	17.553	16.49	17.48	17.62	19.27	17.715
21.6	16.184	16.979	19.380	22.950	18.873	16.38	17.08	19.48	20.35	18.322
Av.	15.627	16.644	17.656	19.571		15.837	16.662	17.732	18.965	
New L.S.D at 0.05	Zn 1.005	Fe 1.005	Interaction 2.010			Zn 1.462	Fe 1.462	Interaction 2.924		

both seasons resulted from 21.6 g Zn + 36.0 g Fe. The beneficial effect of micro nutrients in enhancing vegetative growth was previously mentioned by Twyford (1967) , Jordine (1962) and Ziv (1954).

Also, the importance of these minerals in the multibiological processes, like the role of Zn in the synthesis of IAA was reported by Nason (1950)

Data in Table (3) show that increasing the rate of Zn-fertigation gradually and significantly shortened the time to flowering. Yet, the period to flowering is 411.0, 398.75, 393.75, 384.5 and 414.5, 424.25,423.25, 401.0 days in 0.0, 5.4, 10.8 and 21.6 gm/plant treatments respectively in both seasons.

With the effect of Fe- fertigation rates on the period to flowering, the uppermost tested rate (36.0 gm/plant) shortened the period to flowering than the other treatments (415.0 and 424.75 days against 398.75 and 415.75 days and 389.75 and 419.0 days) for 0.0, 9.0 and 18.0 gm/plant in both seasons respectively. Interaction studies between the two main factors indicated that, the time to flowering was statistically significant. It was clear that, the treatment (21.5g.Zn+ 36.0g Fe/plant) was the most effective in shortening the time to flowering in both seasons. The beneficial effect of micro nutrients in regulating bunch shooting may be due to its role in improving the vegetative growth which in turn enhances the emergence of floral inflorescences as reported by Swidan (1972), who noticed that the differentiation of inflorescences in banana plants cv. Hindi is positively correlated with the total leaf area per plant.

Data in Table (3) showed that gradual increasing the rate of Zn- fertigation gradually and significantly shortened the time to harvesting. Yet, the period to harvesting is 509.5; 494.2; 487.5; 479.5 and 544.0; 535.75; 537.0; 513.75 days in 0.0, 5.4, 10.8 and 21.5 gm/plant treatments respectively in both seasons. With the effect of Fe- fertigation rates on the period to harvestng, the uppermost tested rate (36.0 gm/plant) shortened the period to harvesting than the other treatment (510.5, 533.25 days against 497.5, 540.75 days and 485.25, 530.25 days) for 0.0, 9.0 and 18.0 gm/plant treatments in both seasons respectively. Interaction studies between the two main factors concerning the time to harvesting were statistically significant. It was clear that, the treatment (21.6g.Zn+ 36.0g Fe/plant) was the effective in shortening the time to harvesting in both seasons.

Table3. Effect of Zn and Fe fertigation on time of flowering and time of harvesting over two crop cycles (2008/2009-2009/2010)

Time to flowering (days)

Zn-fertigation rates gm./ plant	**First season**					**Second season**				
	Fe-fertigation rates gm./plant									
	0.0	9.0	18.0	36.0	Av.	0.0	9.0	18.0	36.0	Av.
0.0	425	425	404	390	411.0	432	415	416	395	414.5
5.4	420	395	395	385	398.75	442	435	425	395	424.25
10.8	420	390	380	385	393.75	430	423	420	420	423.25
21.6	395	385	380	378	384.5	395	390	415	404	401.0
Av.	415.0	398.75	389.75	384.50		424.75	415.75	419.0	403.50	
New L.S.D at 0.05	Zn 2.630	Fe 2.630	Interaction 5.262			Zn 2.948	Fe 2.948	Interaction 5.896		

Time to harvesting (days)

Zn-fertigation rates gm./ plant	**First season**					**Second season**				
	Fe-fertigation rates gm./plant									
	0.0	**9.0**	**18.0**	**36.0**	**Av.**	**0.0**	**9.0**	**18.0**	**36.0**	**Av.**
0.0	515.0	520.0	511.0	542.0	509.5	568.0	560.0	535.0	515.0	544.0
5.4	532.0	485.0	485.0	475.0	494.2	505.0	540.0	541.0	557.0	535.75
10.8	510.0	490.0	475.0	475.0	487.5	540.0	548.0	530.0	530.0	537.0
21.6	485.0	495.0	470.0	468.0	479.5	520.0	515.0	515.0	505.0	513.75
Av.	510.5	497.5	485.25	490.0		533.25	540.75	530.25	526.75	
New L.S.D at 0.05	Zn 2.674	Fe 2.674	Interaction 5.348			Zn 2.978	Fe 2.978	Interaction 5.956		

Data in Table (4) showed that, bunch characteristics (Bunch weight and average number of hand per bunch) significantly varied in response to Zn and Fe fertigation treatment. Bunch characteristics were significantly increased by increasing the Zn-fertigation rate, the heaviest bunches were produced in plants received the high amount of Zn and Fe fertigation treatment (21.6g Zn+ 36.0g/plant) and the lightest bunches were obtained from the plants without Zn and Fe fertigation (0.0gZn+ 0.0g Fe/plant)

As for number of hands/bunch, the greatest number of hands/bunch (12.0 and 13.2) and number of fingers/ bunch (240.20 and 197.9) in both seasons respectively were obtained from plants received the high amount of Zn and Fe fertigation.

Concerning weight of finger (Table 5) the heaviest finger was produced in plants received the high amount of Zn and Fe fertigation treatment (21.6g Zn+ 36.0g/plant) and the lightest finger was obtained from the plants without Zn and Fe fertigation (0.0gZn+ 0.0g Fe/plant). Results of the effect of different Zn rates on the yield of banana were in harmony with the finding of (Abdel- Kader,1986; Abdel-Kader *et al*., 1992, Ghanta and Mitra 1993 and Sallam *et al.*,2002). Interaction between the two main factors concerning bunch characteristics was statistically significant which referred to Zn and Fe fertigation act dependently in this respect Table (4).

Data in Table (5) revealed that the heaviest weight of hands were produced in plants received the high amount of Zn and Fe–fertigation treatment (21.6g.Zn + 36.0g.Fe/plant) and the lightest hands were obtained form plants without fertigation with Zn and Fe fertigation. For example heaviest hand was (2100.0g and 2000.7g.) and the highest number of fingers/hand (20.20 and 21.3) respectively in both seasons.

Table 4. Effect of Zn and Fe fertigation on bunch characteristics of GrandNain banana plants during 2008/2009-2009/2010

Zn-fertigation Rates gm./plant	First season					Second season				
	Fe-fertigation rates gm./plant									
	0.0	9.0	18.0	36.0	Av.	0.0	9.0	18.0	36.0	Av.
	Bunch weight/plant(kg)									
0.0	23.83	28.70	29.90	35.65	29.52	23.90	27.70	29.56	34.50	28.91
5.4	23.90	30.69	35.86	40.34	32.70	25.50	32.0	35.80	36.55	32.46
10.8	25.17	34.66	35.87	42.77	34.62	26.80	30.50	36.33	38.70	33.08
21.6	25.80	35.66	38.79	43.00	35.81	28.80	30.70	33.90	39.50	33.22
Av.	24.67	32.43	35.10	40.44		26.25	30.22	33.90	37.31	
New L.S.D	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	0.847	0.847	1.694			2.222	2.222	4.444		
	Average number of hands per bunch									
0.0	9.75	10.30	10.60	11.00	10.41	10.0	10.3	10.5	11.0	10.45
5.4	10.00	10.33	11.00	11.00	10.58	10.6	10.9	11.0	11.0	10.87
10.8	10.20	11.00	11.00	11.00	10.80	11.0	11.0	11.0	12.0	11.25
21.6	10.86	11.00	12.00	12.00	11.46	11.3	11.8	12.6	13.2	12.22
Av.	10.20	10.66	11.15	11.25		10.72	11.0	11.27	11.8	
New L.S.D	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	1.208	1.208	2.417			0.939	0.939	1.879		
	Average number of fingers/bunch									
0.0	171.12	190.55	200.06	220.80	195.63	157.6	171.5	179.6	190.5	174.8
5.4	190.28	209.60	231.67	220.03	212.89	166.9	177.6	180.7	194.3	179.87
10.8	190.84	200.86	231.37	220.80	210.97	169.6	180.5	186.5	196.5	183.27
21.6	200.20	220.00	220.50	240.20	220.22	172.3	182.5	193.3	197.9	186.5
Av.	188.11	205.25	220.9	225.46		166.6	178.0	185.0	194.8	
New L.S.D	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	2.545	2.545	5.090			2.375	2.375	4.750		

Table 5. Effect of Zn and Fe fertigation on hand characteristics of GrandNain banana plants during 2008/2009-2009/2010

Hand weight (g)

Zn-fertigation rates gm./ plant	First season					Second season				
	Fe-fertigation rates gm./plant									
	0.0	9.0	18.0	36.0	Av.	0.0	9.0	18.0	36.0	Av.
0.0	761.2	1461.70	1681.80	1827.50	1433.0	876.2	1450.5	1661.7	1807.3	1448.92
5.4	1666.80	1674.30	1774.50	1779.30	1723.72	1665.7	1770.3	1773.5	1780.4	1747.47
10.8	1695.40	1780.90	1801.10	2100.00	1844.35	1679.5	1779.9	1800.3	1900.7	1790.1
21.6	1794.80	1837.00	2071.80	2100.00	1950.9	1799.5	1885.0	1970.8	2000.7	1914.0
Av.	1479.55	1688.47	1832.3	1951.7		1505.22	1721.42	1801.57	1872.27	
New L.S.D at 0.05	Zn 27.682	Fe 27.682	Interaction 55.364			Zn 34.600	Fe 34.600	Interaction 69.201		

Average number of fingers/hand

	0.0	9.0	18.0	36.0	Av.	0.0	9.0	18.0	36.0	Av.
0.0	19.00	19.28	20.20	20.20	19.67	19.0	19.5	20.0	20.5	19.75
5.4	19.50	20.00	21.00	20.20	20.17	19.3	20.0	20.2	21.0	20.12
10.8	19.20	20.44	20.50	21.28	20.35	19.5	20.0	20.3	20.5	20.07
21.6	20.00	20.00	20.20	20.20	20.1	20.5	21.0	21.2	21.3	21.00
Av.	19.42	19.93	20.47	20.47		19.57	20.12	20.42	20.82	
New L.S.D at 0.05	Zn 0.986	Fe 0.986	Interaction 1.972			Zn 0.421	Fe 0.421	Interaction 0.842		

Weight of finger (g)

	0.0	9.0	18.0	36.0	Av.	0.0	9.0	18.0	36.0	Av.
0.0	19.00	19.28	20.20	20.20	19.67	65.2	71.5	77.6	89.0	75.82
5.4	20.00	20.00	20.20	20.20	20.10	66.6	76.7	78.9	90.0	78.05
10.8	19.50	20.00	21.00	20.20	20.17	75.9	79.7	82.5	95.0	83.27
21.6	19.20	20.44	20.50	21.28	20.35	78.8	82.9	87.5	96.1	86.32
Av.	19.42	19.93	20.47	20.47		71.625	77.7	81.625	92.525	
New L.S.D at 0.05	Zn 0.986	Fe 0.986	Interaction 3.972			Zn 0.421	Fe 0.421	Interaction 2.952		

Macro and micro elements were determined in the leaves of tested Grand Nain banana as affected by Zn and Fe- fertigation rates in two tested seasons of investigation (Table 6). The data in the Table showed that N- concentration in leaf of treated plants tended to increase by increasing rate of N- fertigation gradually in the two tested seasons. The highest values of N-concentration in this concern were noticed with 21.6g.Zn./plant.

Data recorded in Table (6) showed clear increasing effect of Fe-fertigation on nitrogen concentration in banana leaves during two examination seasons.Nitrogen concentrations in leaves were increased by increasing Fe- fertigation rates. The effects of interactions between Zn and Fe-fertigation on leaf N content are presented in Table (6). It is clear that all the possible interactions were statistically significant which indicate a high degree of interdependence between the studied nutrients. The highest values for N concentration in two tested seasons resulted from 21.6g.Zn+36.0g.Fe/plant

The obtained data showed clear increase in leaf P concentration as Zn- fertigation treatment was increased; 21.6g.Zn gave the highest concentration than the other treatments. Regarding leaf P content in response to Fe-fertigation rate, 36.0g.Fe/plant treatment gave the highest concentration as compared with other treatments in two seasons.

Leaf K content tends to increase with increasing rate of Zn -fertigation.

For instance, K concentrations were 3.021, 3.157; 3.157, 3.252; 3.265, 3.347, 3.358 and 3.39% in treatments of 0.0, 5.4, 10.8, 21.6g.Zn/plant in two tested seasons. K concentrations in GrandNain leaves tend to increase as Fe- fertigation rates were increased.

Table 6. Effect of Zn and Fe fertigation on leaf mineral content of GrandNain banana cultivar over two crop cycles (2008/2009-2009/2010)

Zn-fertigation rates gm./plant	First season					Second season				
	Fe-fertigation rates gm./plant									
	0.0	9.0	18.0	36.0	Av.	0.0	9.0	18.0	36.0	Av.
Leaf N content %										
0.0	2.96	2.16	2.16	3.35	2.66	2.43	2.46	2.46	2.53	2.47
5.4	3.35	3.35	3.54	3.54	3.45	2.53	2.53	2.56	2.60	2.55
10.8	3.74	3.74	3.74	3.74	3.74	3.13	3.20	3.35	3.48	3.29
21.6	3.93	3.93	3.93	3.93	3.93	3.66	3.76	3.80	3.91	3.78
Av.	3.50	3.29	3.34	3.64		2.94	2.99	3.04	3.13	
New LSD	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	0.21	0.20	0.021			0.48	0.21	0.41		
Leaf P content %										
0.0	0.553	0.575	0.587	0.635	0.587	0.410	0.466	0.475	0.492	0.607
5.4	0.658	0.677	0.711	0.712	0.689	0.520	0.630	0.670	0.741	0.812
10.8	0.740	0.743	0.790	0.796	0.767	0.741	0.747	0.780	0.793	0.957
21.6	0.797	0.833	1.275	1.880	1.196	0.799	0.800	0.988	1.321	1.276
Av.	0.687	0.707	0.841	1.006		0.810	0.617	0.661	0.728	
New LSD	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	0.014	0.01	0.017			0.011	0.01	0.014		
Leaf K content %										
0.0	3.007	3.007	3.035	3.035	3.021	3.100	3.130	3.200	3.200	3.157
5.4	3.064	3.150	3.208	3.208	3.157	3.130	3.200	3.320	3.360	3.252
10.8	3.236	3.265	3.265	3.294	3.265	3.320	3.330	3.360	3.380	3.347
21.6	3.323	3.351	3.380	3.380	3.358	3.380	3.380	3.390	3.410	3.390
Av.	3.157	3.193	3.222	3.229		3.232	3.260	3.317	3.337	
New LSD	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	0.21	0.18	0.22			0.15	0.20	0.24		
Leaf Zn content %										
0.0	10.820	10.995	11.610	11.955	11.345	10.33	10.44	10.56	10.66	11.08
5.4	12.510	12.565	12.690	12.995	12.69	10.66	11.00	11.33	11.33	10.497
10.8	13.065	13.255	13.315	13.315	13.237	13.33	14.00	14.00	14.33	13.915
21.6	13.795	15.780	15.850	17.060	15.621	14.44	17.50	17.66	18.10	16.925
AV.	12.547	13.149	13.366	13.831		12.19	13.235	13.387	13.605	
New LSD	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	1.21	1.04	1.34			1.21	1.04	1.23		
Leaf Fe content ppm										
0.0	62.50	63.50	77.00	81.00	71.00	60.00	61.00	65.00	67.00	63.25
5.4	71.50	74.75	80.50	84.60	77.84	61.00	65.00	74.00	73.00	68.25
10.8	78.50	83.00	86.25	89.00	84.19	71.00	74.00	80.00	89.00	78.50
21.6	81.25	86.25	89.50	94.25	87.81	81.00	86.00	89.00	94.00	87.50
Av.	73.44	76.87	83.31	87.21		68.25	71.5	77	80.75	
New L.S.D	Zn	Fe	Interaction			Zn	Fe	Interaction		
at 0.05	4.11	3.71	4.21			4.21	2.91	4.31		

The highest values of K-concentrations in the leaves were noticed with 36.0 g.Fe/plant treatment (3.229 and 3.337%) respectively. However, low rate of Fe-fertigation (9.0g. Fe/plant) minimized the K concentration (3.193 and 3.26%) in two seasons, respectively. Interaction studies showed significant differences between the two main factors concerning leaf K content in response to Zn and Fe fertilization

The tabulated data showed that Zn and Fe concentration in GrandNain banana leaves varied according to Zn and Fe fertigation. For example, leaf Zn and Fe content tended to increase with increasing rate of Zn- fertigation. Nevertheless, the low rate of Zn and Fe-fertigation(5.4g.Zn and 9.0g.Fe /plant) gave the lowest values of Zn and Fe concentration in the leaves in the two seasons. It is clear that in the two tested season interactions (ZnxFe) were statistically significant in affecting leaf Zn and Fe content. Analogical results in this respect were reported on banana plants by many investigators Abdel-Kader *et al*., 1992 and Ghanta and Mitra 1993.

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الملخص العربي

تأثير التسميد بالزنك والحديد على نمو ومحصول الموز صنف جراندنان فى الاراضى الرملية

فريده عبد الحميد عبد ربة

فى تجربة حقلية على نباتات الموز جراندنان (نباتات منتجة من مرستيمات زراعة أنسجة من الصنف جراندنان) النامى فى مزرعة خاصة بالخطاطبة– محافظة المنوفية خلال موسمين متتاليين لتحديد الاحتياجات السمادية من الزنك والحديد حيث أضيفت للنباتات معدلات مختلفة من الزنك والحديد من خلال ماء الرى(حيث تروى بالتنقيط) وكانت المعدلات(0و 0 و 4و5 و 8و10 و6و21 جرام/نبات سلفات زنك)و (0و 0 و 0و9 و 0و18 و0و36 جرام/نبات حديد مخلبى).وقد أضيفت كل المعدلات المختبرة من الزنك والحديد شهريا" ابتداء" من شهر أبريل الى اكتوبر وكانت الاضافة فى شكل محاليل مع ماء الرى. وقد اظهرت النتائج أن زيادة معدلات التسميد من كل من الزنك والحديد أعطت زيادة فى أرتفاع النبات ومحيط الساق الكاذبة وأيضا" عدد الاوراق ومساحة الاوراق كما قللت عدد الايام اللازمة حتى مرحلة خروج النورة (التزهير) وكذلك عددالايام اللازمة حتى الحصاد وقد كان الزنك له أعظم الاثر فى ذلك.

كما أن المعدل الاعلى للتسميد بالزنك (6و21جرام زنك/نبات) اعطى أعلى زيادة فى صفات النمو والمحصول. كما بينت النتائج أن التسميد بالحديد بمعدل 0و 36 جرام/نبات سبب زيادة معنوية فى النمو وصفات السوباطات والاصابع. كما أن زيادة معدلات التسميد بالزنك والحديد يزيد محتوى الاوراق من النتروجين والفوسفورو البوتاسيوم وكذلك الزنك والحديد.

وبناء" على نتائج الدراسة يمكن التوصية بالتسميد بالزنك والحديد للموز جراندنان بالاراضى الرملية بمعدلات 6و21 جرام/نبات من الزنك وكذلك أضافة 0و36 جرام/نبات من الحديد المخلبى شهريا" ابتداء" من شهر أبريل– أكتوبر.