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EFFECT OF SPRAYING SOME MICROELEMENTS ON YIELD AND FRUIT QUALITY OF HINDY BANANA

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ABSTRACT

This investigation was carried out during 2000 and 2001 seasons in Badawy village to study the effect of application of Zn (0.5%), Cu (0.5%), B (0.05%) either alone or in combination, in addition to the control, four times (April, May, June and July) on the growth, yield, fruit quality and leaf mineral content of Hindy banana.

The obtained results revealed that the combined effect of Zn, Cu and B enhanced plant growth, i.e. plant height and diameter and sucker length. Also, it increased fruit yield and improved fruit quality. Moreover, foliar spraying of Zn, Cu and B increased banana Leaf contents from N, P, K, Zn, Cu and B .

INTRODUCTION

Few decades ago, fertilization became one of the most important problems in plant production in Egypt, particularly after the High Dam construction which prevented the annual addition of mud which can be carried by water from the Abyssianian mountains to the River Nile Valley of Egypt. Due to this factor, plants are not only needed to macro nutrients, but also to micro nutrients (Shawky *et al.*, 1986).

Banana (*Musa cavendeshi*) is considered as one of favorite popular fruit crops in Egypt. However, little work has been carried out, especially in the case of trace elements.

Hamam (1988) indicated that, mixture of copper, zinc and manganese significantly increased the yield of Hindy banana plants and improved fruit physical properties as well as reduced starch percentage. Spraying the plant with the mixture of Cu, Zn and Mn was more effective in this respect than that using any of them solitary.

The highest fruit yield (196.25 q/ha), individual fruit weight, fruit size and pulp:peel ratio were obtained with foliar application of 0.3% Zn + 0.1% Cu + 0.2% B at 3 and 5 months after planting. Fruit quality (in terms of TSS, total sugar, reducing sugar) was also highest with this treatment (Ghanta and Dwivedi, 1993).

Ghanta and Mitra (1993) applied the micronutrients Zn (0.3% zinc sulfate), Cu (0.1% copper sulfate), B (0.2% boric acid) and Mo (0.05% ammonium molybdate) as foliar sprays alone and in combination, 3 and 5 months after planting sword suckers. Zn + Cu + B treatment gave the best growth response, characterized by plant height, basal girth of the pseudostems and number of leaves/plant. Application of micronutrients caused an increase in leaf N, P and K contents. Zn + Cu + B treatment also resulted in the highest number of hands (7.5/bunch), bunch weight (7.85 kg) and yield (196.25 q/ha).

In a field experiment, banana cv. Barjahaji plants were given foliar sprays of trace elements in addition to NPK fertilizers. Zn, Fe, Cu and B were applied separately at 0.5, 0.2, 0.2 and 0.1%, respectively, or in 3 combinations at the same rates. Vegetative growth was assessed at the flower initiation stage (6 months after planting) and at the shooting stage. Compared with controls, trace element application increased plant growth. A combination of Zn and Fe had the greatest effect (Pertin and Das, 1996).

Hecht *et al.* (1998) evaluated the effect of Zn nutrition on Fusarium wilt caused by *F. oxysporum* using the banana cultivars Dwarf Cavendish and Grande Naine. They found that a significant decrease of severity and incidence of Fusarium wilt by foliar Indol acetic acid (IAA) spray. The increased resistance was more pronounced with Zn compared with Zn deficient conditions.

Therefore, this investigation aimed to study the effect of Zn, Cu and B micro-nutrients on yield and quality characteristics of Hindy banana.

MATERIALS AND METHODS

Two field experiments were carried out at a private orchard in Badawy vallige near Mansoura City, Dakahlia Governorate during 2000 and 2001 seasons. The banana planted in loamy-clay soil. The mechanical and chemical analysis of the soil are presented in Table (1). The banana orchard was established in 1997, with spacing of 2.5 m within rows and 3.0 m between rows.

Table (1): Some chemical analysis of the experimental soil.

EC ds/m	PH	Soluble anion (mg/kg soil)			Soluble cations (mg/kg soil)			Available (mg/kg soil)		
		HCO_3^-	Cl^-	So_4^-	Ca^{++}	Mg^{++}	Na^+	N	P	K
0.47	7.9	0.00	0.80	0.60	0.80	0.60	0.50	0.40	0.50	0.30

This study included five treatments as following:

1- Control (tap water).
2- Foliar application with Zn at the rate of 0.5% Zn EDTA (12% Zn).
3- Foliar application with Cu at the rate of 0.5% Zn EDTA (6 % Cu).
4- Foliar application with B at the rate of 0.05% (Boric acid, 99.5% B).
5- Foliar application with Zn + Cu + B.

The foliar application of elements were done four times in April, May, June and July in both growing seasons. Super-film was added at 0.5 ml per liter as a surfactant for every nutrient solution or control and the trees were sprayed till runoff (about 800 l/fad). Each treatment was replicated three times (10 plants for each replicate). All plants under the experiment received the same agricultural practices according to the recommendation of Ministry of Agriculture and Land Reclamation.

Measurements:

I- Leaf mineral content:

At bunching stage (August), leaf samples (petioles) were taken from third fully open leaves as recommended by Bhargava and Reddy (1992). About 100-grams of fresh weight of petioles were oven dried at 70 °C then

ground for determining the macro and micro-nutrients. Total nitrogen was determined as described by Pregl (1945). Phosphorous was estimated by using the method of Shapuan and Pratt (1961). Potassium was determined by the photometric method as described by Brown and Lilliland (1946). Zn, Cu and B were estimated using an atomic absorption spectrophotometer as described by Brandifeld and Spincer (1965).

Harvest date was estimated when the top hands and fingers became roundish and turned slightly yellow according to Van loescke (1950).

II- Vegetative growth:

At harvest date, plant height and circumference of pseduostem were determined as described by Abou-Aziz *et al.* (1984).

]III. Yield and its component:

The bunch of each plant was harvested and plant yield in response to different treatments was handled as follows: bunch weight (kg), number of hands per bunch and number of fingers per hand were calculated.

IV. Fruit physical characteristics:

1. Average finger weight: samples of 20 fingers were weighted and the average weight was calculated per (g).
2. Average finger length and diameter; were determined using a vernier caliper (cm).
3. Angulation percentage: the equatorial diameter of two different sides were measured by using virnier caliper and angulation percent was estimated using the following equation (Abou-Aziz *et al.*, 1984):

$$\text{Angulation \%} = \frac{\text{Mean of highest reading - Mean of lowest reading}}{\text{Mean of highest reading}}$$

One hand from middle of the mature bunch was taken from each individual plant to determined peel and pulp of finger as well as starch content. Thus, fruits were artificially ripened by dipping in 500 ppm ethephone solution for one minute and kept under room temperature (20±4 °C).

4. The weight of peel & pulp of the finger in grams, then the pulp/peel ratio was delivered.
5. Starch content:

Starch in matured fruits were determined using a colormetric method with 420 nm wave length as described by Forsee (1938).

Statistical analysis:

The obtained data were subjected to the statistical analysis as the technique of analysis of variance (AOV) of randomized complete blocks design as mentioned by Gomez and Gomez (1984). Treatment means were compared using the new least significant differences (N-LSD) procedure as published by Waller and Duncans (1969).

RESULTS AND DISCUSSION

1. Vegetative growth:

Date in Table (2) show that the combined application of Zn, Cu and B as foliar on banana plants gave the highest plant height, thickness of diameter

and sucker values compared with the single micro-elements or control treatments. Zn application ranked the second in this concerning. On the other hand, the lowest values of these aforementioned traits were found with the control treatment. These results are true in both seasons in this study. The importance of micro-nutrients to plant growth and productivity may be due to their role on the multibiological process like role of Zn in the synthesis of IAA as reported by Nason (1950). Also, its may be due to the role of Zn in increase resistance to Fusarium wilt, this mean promoted the growth of treated plants (Hecht *et al.*, 1998).

The similar results were obtained by Ghanta and Mitra (1993) and Pertin and Das (1996).

Table (2): Plant height, circumference and sucker length of Hindy banana in response to micronutrients in 2000 and 2001 seasons.

Characters	Plant height (cm)		Plant diameter (cm)		Sucker length (cm)	
Treatments	2000	2001	2000	2001	2000	2001
Control	194.3	189.0	70.3	67.7	90.0	86.7
Zn at 0.5%	201.7	200.0	74.3	73.3	109.0	96.7
Cu at 0.5%	195.0	191.7	72.3	70.3	100.0	86.7
B at 0.05%	200.0	198.3	71.0	70.0	103.3	93.3
Zn+Cu+B	210.7	205.0	80.3	77.3	115.0	106.7
N-LSD at 5%	8.4	6.2	2.5	5.2	6.5	7.4
1%	---	9.0	3.7	7.6	9.5	10.8

2. Yield and its components:

Data presented in Table (3) reveal that there are no significantly increased differences in numbers of hand /bunch and finger/hand as affected by all examined foliar application in the two seasons. Whereas, finger weight is significantly affected by foliar application of micronutreints. The combined treatment (Zn+Cu+B) produced the heaviest finger weight as compared to the other micronutreints and control. The increment due to this treatment reached to 33.81 % over the untreated plants.

Regarding the yield /plant, data in the same table clearly indicate the significant increase in yield as affected by foliar application. Spraying with mixture of Zn at 0.5%, Cu at 0.5% and B 0.05% produced the highest bunch weight compared with other treatments. Over both seasons, the corresponding fruit yield for the treatments of control, Zn, Cu, B and their combined (Zn, Cu, B) were 11.00, 14.17, 12.34, 12.34 and 18.00 kg, respectively. The yield increased by 63.64 and 28.82% due to plants sprayed by Zn+Cu+B or Zn at 0.5%, respectively compared to the control. The increment in yield of combined application (Zn+Cu+B) might be due to the increase in yield attributes i.e. number of hand, number of finger and finger weight. Since, yield calculated by multiply these characters. Also, this increment in yield is due to response of micronutreints in enhancing vegetative growth (plant height and diameter) as shown in Table (2).

These results are in agreement with Hamam (1988); Ghanta and Dwivedi (1993) and Ghanta and Mitra (1993).

Table (3): Hand and finger numbers, finger weight as well as yield of Hindy banana in response to micronutrients in 2000 and 2001 seasons.

Characters	No. of hands/ bunch		No. of fingers /hand		Finger weight (g)		Yield (kg) /plant	
Treatments	2000	2001	2000	2001	2000	2001	2000	2001
Control	8.3	7.3	17.3	18.7	77.7	81.7	10.67	11.33
Zn at 0.5%	8.3	7.7	18.7	19.3	95.0	93.7	14.67	13.67
Cu at 0.5%	7.7	7.7	19.3	18.0	92.3	89.0	11.67	13.00
B at 0.05%	8.0	7.7	20.0	18.7	89.3	88.0	12.00	12.67
Zn+Cu+B	8.7	8.3	21.0	20.3	110.0	103.3	18.33	17.67
N-LSD at 5%	NS	NS	NS	NS	6.7	5.9	2.31	2.93
1%					9.8	8.5	3.42	4.26

3. Fruit physical characteristics

Results of the statistical analysis show that finger length, diameter and angulation percentage were significantly differed due to micronutrients application and this was true in both seasons of study (Table 4). It is clearly appeared that finger length and finger diameter were increased with the application of Zn+Cu+B. Zn and B application came in the second rank without significant variation in their effect on length and diameter of fingers. On the other side, angulation percentage was significantly decreased with the combined effect of Zn+Cu+B where recorded the lowest value of this respect. Meanwhile, the highest angulation percentage was shown with the control treatment, i.e. without micronutrients application. Hamam (1988) came to the same result on Hindy banana cultivar.

Table (4): Length and diameter of finger as well as angulation of Hindy banana cv in response to micronutrients in 2000 and 2001 seasons.

Characters	Finger length (cm)		Finger diameter (cm)		Angulation ((%)	
Treatments	2000	2001	2000	2001	2000	2001
Control	20.0	18.3	2.7	2.5	9.80	10.19
Zn at 0.5%	22.0	21.0	2.9	2.7	9.53	9.90
Cu at 0.5%	20.7	21.3	2.7	2.7	9.31	9.45
B at 0.05%	20.0	18.7	2.8	2.8	9.52	9.83
Zn+Cu+B	24.0	23.0	3.3	3.0	9.27	9.45
N-LSD at 5%	2.02	1.38	0.34	0.31	0.06	0.10
1%	2.91	2.00	NS	NS	0.09	0.15

Also data presented in Table (5) show that pulp weight, peel weight, pulp/peel ratio and starch percentage are markedly affected by the examined micronutrients application. The highest values in both growing (as an average of the two seasons) seasons of pulp weight (48.8 g) and peel weight (49.15) were produced with the application of Zn + Cu + B which significantly surpassed the other treatments. Cu application ranked the second in pulp

weight, while Zn application ranked the second in peel weight. Pulp/peel ratio and starch percentage reached its maximal in case of the control treatment. Moreover, this result is in harmony with the findings of Hamam (1988).

Table (5): Averages of peel, pulp weights and pulp/peel ratio as well as starch content of Hindy banana cv in response to micronutrients during 2000 and 2001 seasons.

Characters	Pulp weight (g)		Peel weight (g)		Pulp/peel ratio		Starch %	
Treatments	2000	2001	2000	2001	2000	2001	2000	2001
Control	43.7	41.7	41.0	40.3	1.06	1.03	66.87	67.37
Zn at 0.5%	44.3	40.3	46.3	42.7	0.96	0.95	65.00	66.53
Cu at 0.5%	45.7	43.3	43.0	40.3	1.06	1.07	64.80	65.47
B at 0.05%	40.3	39.7	41.3	39.3	0.98	1.01	65.43	66.13
Zn+Cu+B	48.7	49.0	49.3	49.0	0.99	1.00	64.40	65.33
N-LSD at 5%	2.60	3.18	1.93	0.97	0.08	NS	0.48	0.47
1%	3.7	4.62	2.81	1.42	NS	NS	0.70	0.69

4. Leaf mineral content

Leaf contents from N,P,K, Zn, Cu and B are significantly affected by the examined micronutrients application. Data collected in Table 6 reveal that there are marked increases in N, P and K with the application of micronutrients, compared with the control. The highest averages of N, P and K were produced with combined application of Zn + Cu + B. The same result was reported by Ghanta and Mitra (1993). They found that application Zn+Cu+B treatment increased NPK content in leaf of banana plants. Also, Abdel-Kader *et al.* (1992) obtained similar results on Hindi banana. This may be due to the role of Zn which stimulated the absorption of nitrogen in olive and guava seedlings (Behairy *et al.*, 1985)

Table (6): Averages of nitrogen, phosphorous, potassium, zinc, copper and boron contents in leaves of Hindy banana cv in response to micronutrients during 2000 and 2001 seasons.

Characters	N (%)		P (%)		K (%)		Zn (ppm)		Cu (ppm)		B (ppm)	
Treatments	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Control	2.20	2.15	0.27	0.19	2.23	2.09	15.3	13.3	12.2	12.7	15.0	11.0
Zn at 0.5%	2.36	2.22	0.31	0.21	2.37	2.30	20.0	16.3	9.0	9.2	14.0	13.0
Cu at 0.5%	2.25	2.17	0.25	0.20	2.2	2.11	16.0	15.3	13.6	13.2	11.1	11.0
B at 0.05%	2.23	2.16	0.27	0.21	2.45	2.35	17.3	14.3	10.1	9.5	16.1	16.0
Zn+Cu+B	2.43	2.40	0.35	0.23	2.56	2.40	21.0	17.0	13.2	13.1	17.0	17.0
N-LSD at 5%	0.07	0.06	0.05	0.02	0.04	0.06	2.0	1.5	0.3	0.4	1.1	0.2
1%	0.11	0.09	0.07	NS	0.06	0.09	2.9	2.2	0.4	0.5	1.6	0.3

Single application of Zn, Cu or B and their combined were associated with the highest values of Zn, Cu and B in banana leaves. There is no surprising with this result, because the application of each element to banana plants leads to an increase in its content in plant tissues. The same result is expected with their combined application.

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تأثير الرش ببعض العناصر الصغرى على المحصول وجودة الثمـــار فـــى المـــوز الهندى

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*** قسم بحوث البساتين ــ المركز القومى للبحوث ــ الدقى ــ القاهرة

أجري هذا البحث خلال موسمي ٢٠٠٠ و ٢٠٠١ فى مزرعة خاصة بقرية بداوى بالقرب من المنصورة بهدف دراسة تأثير الرش بالمغذيات الصغرى من الزنك مخلبى ٠,٥% أو النحـــاس المخلبى ٠,٥% أو البورن ٠,٠٥% فى صورة منفردة أو متحدة أربع مرات (إبريـــل ــ مـــايو ــ يونيو ــ يوليو) على الموز الهندى. وكانت أهم النتائج كما يلى:

ــ رش نباتات الموز الهندى بالعناصر المغذية الصغرى مجتمعة أدى إلى تحسن النمو الخضـــرى المتمثل فى طول وقطر النبات وكذلك طول الخلفة عن اضافتها بصورة منفردة أو الكنترول.

ــ أدى الرش بالعناصر السابقة منفردة أو مجتمعة إلى زيادة المحصول زيادة معنوية عند مقارنتـــه بالكنترول كما حسنت من صفات الجودة والصفات الطبيعية للثمار.

ــ زاد محتوى الأوراق من العناصر النتروجين والفوسفور والبوتاسيوم وكـــذا الزنـــك والنحـــاس والبورون نتيجة الرش الورقى للعناصر المختبرة بصورة مجتمعة.

وقد أوصت الدراسة أن الرش بالزنك المخلبى ٠,٥% +النحاس المخلبى ٠,٥% + البورن ٠,٠٥% أدي إلى تحسين النمو وزيادة المحصول وتحسين صفات جودة الثمار وزيـــادة محتـــوى أوراق الموز من العناصر الكبرى (نتروجين،فوسفور، بوتاســـيوم) والصغـــرى (زنـــك، نحـــاس، بورن).