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EFFECT OF DIFFERENT LEVELS OF MINERAL MAGNESIUM ON GROWTH, YIELD AND FRUIT QUALITY OF HINDI BANANA

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ABSTRACT

This experiment was carried out during 2004 & 2005 seasons on Hindi banana plants grown in a private orchard in Dakahlia Governorate to throw some light or the effect of using $MgSO_4$ at 50, 100 and 150 gm/plant as soil application alone or with foliar application at 2 % on growth, yield, fruit quality and chemical composition of leaves and pulp. Soil application at 50 gm Mg/plant served as control.

Results showed that soil application combined with foliar application of Mg at 2 % was favourable in improving all growth parameters, plant length and diameter, leaf length and width, number of hands per bunch, hand and bunch weight, finger weight, size, length and diameter, leaf chlorophyll content, leaf content of N and Mg and pulp content of total carbohydrates and starch percent compared to soil applications only.

The best results with regard to growth, fruit quality, yield and nutritional status of Hindi banana plants were obtained by soil application of $MgSO_4$ at 150 gm/plant and spraying 2 % Mg.

INTRODUCTION

Hindi banana still needs additional information concerning some appropriate practices, which if applied could affect positively bunch and finger characteristics for enhancing the productivity of the plants. Efforts have always been exerted to improve the growth and production of banana through a better understanding of the various horticultural practices particularly nutrition with magnesium.

Magnesium plays an important role in improving growth and nutritional status of the trees. Magnesium plays several important roles especially in activating many plant enzymes and stimulating the biosynthesis of chlorophylls and carbohydrates (Devlin, 1972). Moreover, Maksoud *et al.* (1994) found that $MgSO_4$ application significantly increased total chlorophyll and carbohydrate contents compared with the control.

Irizarrry *et al.* (1990) reported that annual application with Mg at 275 kg/ha gave an optimum yield. Whereas, higher application with Mg at 448 kg/ha in the year increased bunch weight directly in proportion to the exchangeable Mg in the soil. Likewise, Abd EL-Kader *et al.* (1990) mentioned that soil application with $MgSO_4$ at 25 or 50 gm/plant per year, to Maghrabi banana, presented an increment in yield and fruit quality.

EL-Tanahy (1999) found that using magnesium sulphate at 60 or 120 gm/plant each alone as soil fertilization or with foliar application at 2 % increased the bunch weight of Williams banana as well as increasing the content of total carbohydrates, starch in pulp of banana fruits and also increased the content of magnesium in the leaves.

This study was designed to th ow some light on the beneficial effects of soil application and spraying mineral magnesium on the growth, nutritional status and bunch and fruit quality of Hindi banana.

MATERIALS AND METHODS

The present study was carried out during 2004 and 2005 seasons on Hindi banana grown in a private orchard near Mansoura Dakahlia Governorate. The plants spaced at 2.5 x 3.0 meters apart, received the normal cultural practices recommended with Hort. Res. Inst. for banana plantation in Egypt. Seventy two plants uniform in growth and in good physical conditions as possible were chosen and devoted for carrying out this experiment. The experiment was set in a randomized complete block design (Snedecor and Cochran, 1972) with three replicates per each treatment, each replicate consisted of four plants.

Four plants of each block received one of the following treatments :

1- Soil application, 50 gm/plant $MgSO_4$ (Control).
2- Soil application, 100 gm/plant $MgSO_4$.
3- Soil application, 150 gm/plant $MgSO_4$.
4- Soil application with 50 gm/plant and foliar application by $MgSO_4$ at 2 %.
5- Soil application with 100 gm/plant and foliar application by $MgSO_4$ at 2 %.
6- Soil application with 150 gm/plant and foliar application by $MgSO_4$ at 2 %.

The source of Mg was magnesium sulphate (Epson salt, 49 % $MgSO_4$ = 16 % MgO). Soil applications were divided into six equal doses yearly from mid May till mid October. Yet, foliar application was applied in two times, one at June 15th and other at August 15th.

During the two seasons when the top hands have turned slightly yellow according to Van Loesecke (1950), samples of each replicate were collected and transported to the laboratory to determine the physical and chemical properties :

A- Physical properties :

1- Average length and diameter of plant.
2- Average leaf length and width (cm).
3- Average number of hands per bunch.
4- Average weight of bunch and hand in (kg).
5- Average finger weight (gm) and size (ml^3).
6- Average finger length and diameter (cm).

B- Chemical properties :

Leaf samples from each individual plants was taken 15 m strip from each side of the midrib in the middle of blade of the third leaf from the top of the plant at shooting stage as recommended by Hewitt, (1955) and Bhargava and Reddy, (1992).

1- Chlorophyll A and B in the leaves were determined according to Wettstein (1957).
2- Total nitrogen was determined by the calorimetric as described by Yeun and Follard (1952).
3- Potassium was determined by using flame photometer according to Brown and Lilliand (1946).
4- Magnesium was determined according to Piper (1950), samples from the dried pulp were taken to determine the following :

- Total carbohydrates were determined as gm/100 gm dry weight by using the colorimetric method as described by Dubois *et al.* (1956).

- Starch percent was determined in dry weight pulp using Schaffer and Hartman Method, (1921).

The obtained data during both seasons were statistically analyzed according to methods described by Snedecor and Cochran (1972). Differences among various treatments were compared using L.S.D values at probability of 5 %.

RESULTS AND DISCUSSION

A- Vegetative growth :

1- Plant length and diameter :

Data in Table 1 clearly show that all treatments used increased plant length and diameter compared to the control treatment (50 g Mg/plant). All Mg applications, soil and foliar significantly increased plant length and diameter compared to the control. Moreover, 100 g Mg as soil application + 2 % as foliar application gave the highest length and diameter of plant than the all treatments used. Whereas, the control gave the lowest value in this respect. These results were confirmed in both seasons of the study.

The positive influence of using suitable levels of magnesium on the plant length and diameter was previously reported by Wolf *et al.* (1983), Kilany (1992) and Kilany *et al.* (2000) they showed the striking effect of using Mg on growth.

Table (1) : Effect of different levels of mineral magnesium as soil and foliar application on the length and diameter of plant and leaf of Hindi banana during (2004 & 2005 seasons).

Treatments	2004				2005			
	Plant length (cm)	Plant diameter (cm)	Leaf length (cm)	Leaf width (cm)	Plant length (cm)	Plant diameter (cm)	Leaf length (cm)	Leaf width (cm)
50 g Mg/plant*	282	75	160	54	290	80	160	54
100 g Mg/plant	290	81	165	60	293	82	164	60
150 g Mg/plant	295	84	170	59	295	85	171	58
50 g soil ap. + 2 % Mg foliar ap.	303	88	177	61	300	92	179	61
100 g soil ap. + 2 % Mg foliar ap.	311	96	188	69	313	99	183	64
150 g soil ap. + 2 % Mg foliar ap.	305	94	195	73	308	96	187	69
L.S.D at 5 %	3.18	1.95	3.02	4.09	3.84	2.84	2.98	3.62

* 50 gm $MgSO_4$ per plant soil application = control.

2- Leaf length and width :

It can be shown from the data in Table 1 that the effect of Mg treatments used on leaf length and width of banana plants took similar trend to that noticed for plant length and diameter. But, the maximum values were obtained from 150 g Mg soil application combined with Mg at 2 % foliar application compared with the all treatments used and the control in the two seasons of the study. These results are in agreement with those found by Velez-Ramos and Borges (1995) who mentioned that the average length, width and diameter of the fruit were increased significantly as Mg application increased.

B- Yield and fruit quality :

1- Number of hands per bunch :

It is evident from the data in Table 2 that all treatments applied increased the number of hands per bunch than the control. Plants treated with combined treatments with magnesium as soil and foliar applications gave the significant increase compared with using soil applications alone or the control in the two seasons of the study. Furthermore, 150 gm/plant of magnesium as soil application and foliar application at 2 % gave the highest value in this respect than the other treatments used. The minimum number of hands per bunch was detected in vines treated with 50 g mg/plant as soil applications (the control) in both seasons. These results are in line with those found by Turner and Barkus (1983) on Williams banana; Abd EL-Kader *et al.*, (1990) and Abou Aziz *et al.*, (1993) on Maghrabi and Hindi banana.

2- Hand and bunch weight :

Data from Table 2 show clearly that the effect of application used of hand and bunch weight took similar trend to that noticed for number of hands per bunch. Moreover, 100 or 150 gm/plant Mg as soil application combined with magnesium at 2 % as foliar application significantly increased both bunch and hand weight than the control.

Table (2) : Effect of different levels of mineral magnesium as soil and foliar application on number of hand/bunch, hand and bunch weight of Hindi banana during (2004 & 2005 seasons).

Treatments	2004			2005		
	No. of hand per bunch	Hand weight (kg)	Bunch weight (kg)	No. of hand per bunch	Hand weight (kg)	Bunch weight (kg)
50 g Mg/plant*	9.7	1.88	18.2	9.3	1.78	16.6
100 g Mg/plant	10.0	2.20	22.0	10.0	1.85	18.5
150 g Mg/plant	10.0	2.57	25.7	11.0	1.92	21.1
50 g soil ap. + 2 % Mg foliar ap.	11.0	2.60	28.6	11.0	1.95	21.5
100 g soil ap. + 2 % Mg foliar ap.	11.0	2.63	28.9	11.0	2.40	26.4
150 g soil ap. + 2 % Mg foliar ap.	11.2	2.67	29.9	11.3	2.45	27.4
L.S.D at 5 %	0.8	0.11	1.5	0.9	0.10	1.7

*** 50 gm $MgSO_4$ per plant soil application = control.**

The results obtained are in harmony with the findings of Turner and Barkus (1982) who found that bunch weight was increased at all levels of Mg supply. Similar results were reported by Abd EL-Kader *et al.* (1992) on Hindi banana, Irizarry *et al.* (1990) they reported that Mg application increased bunch weight indirect proportion to the exchangeable Mg in the soil and EL-Tanahy (1999).

3- Finger weight, size, length and diameter :

Data presented in Table 3 show that all magnesium applications increased both average finger weight and size than the control.

Foliar application with soil treatments gave higher finger weight and size than using each alone or the control plants. Magnesium application at 150 gm/plant as a soil application with 2 % as foliar treatment gave maximized values in this respect compared with the other treatments used in

the two seasons of this study. Whereas, Mg at 50 gm alone gave the lowest values in fruit weight and size than the other treatments used. Our data are agree with those reported by Turner and Barkus (1982) and EL-Tanahy (1999).

Data from Table 3 indicated that all magnesium treatments used succeed in increasing length and diameter of the finger compared to control (50 g Mg/plant). Soil applications combined with spraying Mg at 2 % significantly increased both finger length and diameter compared to the soil applications only. The maximum value was obtained from 150 g Mg/plant as soil application and Mg at 2 % as foliar treatment in the two seasons of study. Whereas, the minimum values were detected in the control plants. In this respect, Velez-Ramos and Borges (1995) and EL-Tanahy (1999) found that the average length and width of the fruit increased significantly as Mg application increased.

Table (3) : Effect of different levels of mineral magnesium as soil and foliar application on finger weight, size, length and diameter of Hindi banana during (2004 & 2005 seasons).

Treatments	2004				2005			
	Finger weight (gm)	Finger size (ml^3)	Finger length (cm)	Finger diameter (cm)	Finger weight (gm)	Finger size (ml^3)	Finger length (cm)	Finger diameter (cm)
50 g Mg/plant*	73	73	18.1	2.9	69	72	18.4	2.8
100 g Mg/plant	75	74	18.1	3.1	72	72	18.6	2.9
150 g Mg/plant	77	78	18.7	3.4	75	75	18.8	3.3
50 g soil ap. + 2% Mg foliar ap.	83	82	19.4	3.4	79	80	19.1	3.5
100 g soil ap. + 2% Mg foliar ap.	85	81	19.7	3.6	83	83	20.4	3.7
150 g soil ap. + 2% Mg foliar ap.	88	83	18.7	3.7	87	85	20.5	3.9
L.S.D at 5 %	1.43	2.97	0.40	0.19	1.15	4.65	0.21	0.15

* 50 gm $MgSO_4$ per plant soil application = control.

C- Chemical composition :

1- Leaf content of chlorophyll A and B :

As shown in Table 4, it is worthy to mention that all Mg treatments had a higher content of announced chlorophyll A and B than control treatment. Leaves borne on plants receiving magnesium as soil and foliar treatments seemed to contain more chlorophylls than those borne on plants treated with soil applications only. This can be explained in the light of magnesium role as a part of chlorophyll molecule. The maximum values of chlorophyll were obtained from plants received 150 g Mg as soil application + Mg at 2 % foliar application.

These results are in harmony with those obtained by Kilany (1992) on Thompson Seedless grapevines.

2- Leaf mineral content :

Nitrogen and magnesium content :

Data presented in Table 5 clearly show that magnesium either applied to the soil or combined with folia. application enhanced leaf N and Mg as compared with control. Moreover, as Mg application increases leaf N and Mg

content also increases. Also, Mg at 150 gm/plant as soil application and at 2 % as foliar application gave the most pronounced increment in this respect compared to the other treatments used and the control in the two seasons of this study. Our data go in line with those reported by Abd EL-Kader *et al.* (1990) and EL-Tanahy (1999), who found that the percentage of N and Mg in leaves were increased by increasing $MgSO_4$ applications.

Table (4): Effect of different levels of mineral magnesium as soil and foliar application on leaf content of chlorophyll A and B (mg/g fresh weight) of Hindi banana during (2004 & 2005 seasons).

Treatments	2004		2005	
	Chl. A	Chl. B	Chl. A	Chl. B
50 g Mg/plant*	0.18	0.15	0.15	0.15
100 g Mg/plant	0.19	0.16	0.17	0.16
150 g Mg/plant	0.21	0.17	0.19	0.17
50 g soil ap. + 2 % Mg foliar ap.	0.24	0.20	0.22	0.20
100 g soil ap. + 2 % Mg foliar ap.	0.27	0.25	0.25	0.24
150 g soil ap. + 2 % Mg foliar ap.	0.29	0.28	0.26	0.25
L.S.D at 5 %	0.01	0.03	0.02	0.02

*** 50 gm $MgSO_4$ per plant soil application = control.**

Table (5) : Effect of different levels of mineral magnesium as soil and foliar application on nitrogen, potassium and magnesium contents in the leaf of Hindi banana during (2004 & 2005 seasons).

Treatments	2004			2005		
	N (%)	K (%)	Mg (%)	N (%)	K (%)	Mg (%)
50 g Mg/plant*	2.7	2.7	0.30	2.1	2.8	0.27
100 g Mg/plant	2.8	2.6	0.32	2.2	2.7	0.29
150 g Mg/plant	3.2	2.4	0.35	2.4	2.6	0.31
50 g soil ap. + 2 % Mg foliar ap.	3.0	2.3	0.37	2.6	2.6	0.33
100 g soil ap. + 2 % Mg foliar ap.	3.1	2.3	0.39	2.9	2.5	0.36
150 g soil ap. + 2 % Mg foliar ap.	3.3	2.6	0.41	3.2	2.6	0.39
L.S.D at 5 %	0.38	0.10	0.01	0.15	0.05	0.02

*** 50 gm $MgSO_4$ per plant soil application = control.**

Potassium content :

It is obvious from data in Table 5 that all applications used, reduced the values of potassium in the leaves of banana plants compared with the control. In this respect, Abd EL-Kader *et al.* (1990) presented that a significant decreased of K percentage was obtained by increasing the level of $MgSO_4$ applied to banana plants. Also, Wardlaw (1961) found that the amount of potassium in plant tissues was increased when Mg was decreased.

Total carbohydrate :

From data in Table 6, it is obvious that all magnesium applications increased the content of total carbohydrates in pulp of banana fruits than the control. The data also revealed that clear effect had obtained between soil only and (soil + foliar) treatments on total carbohydrate content. Thus, magnesium application at 150 g/plant as soil application with 2 % as foliar application gave a higher significant effect in this respect. Our data go in line with those reported by Maksoud *et al.* (1994) and EL-Tanahy (1999), who

found that the $MgSO_4$ applications as soil and foliar treatments significantly increased total carbohydrates contents.

4- Starch percent :

Results of Table 6 also clearly show that all magnesium applications used increased starch percent in pulp of banana fruits compared with the control. In addition, plants treated with both soil and foliar magnesium gave a more pronounced effect compared to the soil applications alone. Furthermore, plants treated with 150 gm as soil application with foliar application at 2 % gave the higher significant effect in this respect compared with the other treatments used in the two seasons of this study. Similar results were reported by EL-Tanahy (1999), who found that the applications of Mg at 120 gm as soil and 2 % as foliar application gave a more pronounced effect in increasing starch percent in pulp of banana fruits.

According to the results obtained in this investigation, it can be concluded that using magnesium sulphate at 150 gm/plant as soil application with foliar application at 2 % was very promising in improving growth, yield, fruit quality and plant nutritional status of Hindi banana plants compared to magnesium soil application only.

Table (6) : Effect of different levels of mineral magnesium as soil and foliar application on total carbohydrates and starch percentages of Hindi banana (2004 & 2005 seasons).

Treatments	2004		2005	
	Total carbohydrate (%)	Starch (%)	Total carbohydrate (%)	Starch (%)
50 g Mg/plant*	42.4	22.3	40.3	20.5
100 g Mg/plant	44.3	23.3	41.2	21.0
150 g Mg/plant	46.5	24.1	42.5	22.0
50 g soil ap. + 2 % Mg foliar ap.	47.1	24.5	43.4	24.1
100 g soil ap. + 2 % Mg foliar ap.	47.1	25.2	45.9	24.7
150 g soil ap. + 2 % Mg foliar ap.	48.2	25.9	47.1	25.2
L.S.D at 5 %	1.63	0.62	1.06	0.64

* 50 gm $MgSO_4$ per plant soil application = control.

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تأثير مستويات مختلفة من الماغنسيوم المعدنى على النمو والمحصول وجودة الثمار في الموز الهندي.

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أجريت هذه التجربة خلال موسمي ٢٠٠٤ ، ٢٠٠٥ على نباتات الموز الهندي النامية في مزرعة خاصة في محافظة الدقهلية ، لإلقاء بعض الضوء على إختبار تأثير إستخدام مستويات مختلفة من الماغنسيوم المعدنى (سلفات ماغنسيوم) بتركيزات ٥٠ ، ١٠٠ ، ١٥٠ جرام لكل نبات كتسميد أرضى وحدة أو مع الرش بتركيز ٢ % على النمو والمحصول وجودة الثمار ومحتوى الأوراق ولحم الثمار من المواد الكيماوية. وأستخدم الماغنسيوم بمعدل ٥٠ جرام/نبات للمقارنة.

ولقد أشارت النتائج إلى أن رش الماغنسيوم بتركيز ٢ % مع الإستخدام الأرضي كان فعلا في تحسين النمو (طول وقطر النبات – طول وعرض الورقة) – عدد الكفوف للسوباطة – وزن الكف والسوباطة – وزن وحجم وطول وقطر الإصبع – محتوى الأوراق من الكلوروفيل والنيتروجين والماغنسيوم وكذلك محتوى اللحم من الكربوهيدرات الكلية والنسبة المئوية للنشا وذلك مقارنة بإستخدام الماغنسيوم في الأرض فقط.

ولقد أمكن الحصول على أفضل النتائج بالنسبة للنمو وجودة الثمار والمحصول والحالة الغذائية لنباتات الموز الهندي عند إضافة الماغنسيوم في التربة بتركيز ١٥٠ جرام/نبات مع الرش بتركيز ٢ %.