EFFECT OF DIFFERENT LEVELS OF MAGNESIUM ON GROWTH AND NUTRIENT STATUS OF "HINDY" BANANA PLANTS GROWN IN SAND CULTURE.

Journal

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ABSTRACT

This study was carried out during two seasons to study the effect of different levels of magnesium on Hindy banana plants grown in sand culture. The different levels of magnesium in the nutrient solution did not affect vegetative growth significantly. Removing magnesium from the nutrient solution only induced a very limited area at the tip or margins of the blade of older leaf at the base of the pseudostem which appeared chlorotic or burned. When Mg content in the third leaf from the top of the plant attained 0.43- 0.60% it means a lack of magnesium. When plants were supplied with standard nutrient solution, Mg content ranged between 0.76- 0.82%. When magnesium was existed in excess in the nutrient solution, the percentage of Mg in the leaves ranged between 0.89- 0.94%. Removing or reducing magnesium from the nutrient solution increased P, Ca and decreased Mg but had no effect on N while increasing magnesium in the nutrient solution increased N, P and Mg but K, Ca and Na were not affected.

Key words: Magnesium requirements, Sand culture, Hindy banana, growth and mineral content

INTRODUCTION

This experiment was planned to determine the effect of different levels of magnesium on growth and leaf mineral content of young "Hindy" banana plants grown in sand culture. This study may be helpful to determine the low, optimum and high levels of magnesium which in turn will be important in arriving at a proper program for banana fertilization.

MATERIALS AND METHODS

This work was carried out during 1988 and 1990 on young "Hindy" banana *Musa Cavendishii L* in the Faculty of Agriculture, Ain Shams University, Shoubra El kheima, Egypt. In 1989 season, most plants were affected with bunchy top disease and number of replications was decreased, therefore, the results of that season were canceled.

The experiment included five treatments, where all plants were fertilized with the standard nutrient solution of Long Ashton (Hewitt, 1966) which contained the macronutrients but with different concentrations of magnesium. The concentrations of Mg relative to magnesium in the nutrient solution were 0 %, 100% (Standard Nutrient Solution), 200% and 300% in the first season. The analogous concentrations of Mg in ppm were zero, 18, 36, 72 and 108 ppm, respectively.

Since, it was observed that plants treated with different Mg concentration (100, 200 and 300%) gave more or less similar vegetative growth, so the concentrations of magnesium were modified in the second season to be 300 and 600 % to know the effect of Mg excess in the nutrient solution on plant growth. The analogous concentration of Mg in ppm was 108 and 216 ppm , respectively.

For micronutrients, the nutrient solution of Hoagland and Arnon (1958) were added at the rate of one milliliter to one liter of the above diluted macronutrient solution. Furthermore, one milliliter of 0.5% Fe-EDTA was added to one liter of the diluted nutrient solution. The pH of the diluted solution was adjusted to approximately 6.0 – 6.5 by using HCl or NaOH solutions. Plants were supplied every other day with the different diluted solutions at a rate of 1.5 liter/plant. It should be pointed out that all containers were leached weekly by using 1.5 liter/plant deionizer water.

Each treatment was replicated five times on one- plant – plots in a completely randomized design.

During the last week of March of each season, peepers of "Hindy" banana of about 20 cm long were brought from the nursery and one peeper was planted in a plastic container. The dimensions of the container were 40X40 cm for height and diameter, respectively. These plastic containers were filled with sand which was previously treated with 10% commercial hydrochloric acid for 24 hours and thoroughly washed with tap water then washed several times with deionized water to free it from all solutes and any traces of acid.

Thereafter, plants were kept under saran greenhouse. After planting, peepers were irrigated each other day with deionized water at the rate of 1.5 liter/ plant up to the last week of July. At the beginning of August in each season, plants were subjected to different magnesium treatments as mentioned before.

At the end of the growing season in early November of each season, vegetative growth and leaf mineral content were determined as follows:

Vegetative growth:

Length and girth of pseudostem, number of green leaves per plant and leaf area of the third leaf from the top of the plant were calculated by multiplying the length with the width of the leaf.

Mineral analysis:

In early November of each season, a sample of (10X10cm) from the middle part of the blade of the third leaf from the top of each plant was taken as recommended by (Hewitt, 1955). Leaf samples were washed several times with tap water then washed with distilled water. Samples were oven dried at 60-70 °c until a constant weight and then ground in a stainless steel rotary knife mill.

The digestion was carried out by weighting 0.2 g of the ground material using a mixture of perchloric acid: sulphoric acid (1:10, v/v) (Jackson, 1967) and the clear digest was quantitatively transferred to 100 ml volumetric flask. In this solution, each of nitrogen, phosphorus, potassium & sodium and (Calcium & magnesium) were determined by using the methods of Pregl (1946), Truog & Meyer (1929), Brown & Lilleland (1946) and Chapman & Pratt (1961), respectively.

The obtained results were statistically analyzed and Duncan's multiple range test was used to differentiate means (Duncan, 1955).

RESULTS AND DISCUSSION

Vegetative growth:

In the first season (Table 1) reducing, removing or increasing magnesium in the nutrient solution did not significantly affect height and girth of pseudostem, number of green leaves per plant, dimensions and area of the third leaf from the top of the plant when compared with those supplied with (S.N.S.) treatment.

In the second season (Table 1) it is observed that vegetative characteristics were higher than those of the first one. However, the various vegetative measurements were affected slightly by treatments. Nevertheless, it was observed that height and girth of pseudostem tended to be increased slightly by increasing magnesium by 300% in the nutrient solution. More increase (600%) in magnesium in the nutrient solution did not induce any increase than the preceding treatment. On the other hand, reducing magnesium by 50% in the nutrient solution tended to decrease height and girth of pseudostem slightly than those of (S.N.S) treatment. Moreover, removing magnesium from the nutrient solution reduced height and girth of pseudostem slightly than those of (50 % Mg) treatment. The area of the third leaf from the top of the plant showed a similar trend as that of height and girth of pseudostem. Other characteristics did not show any particular trend.

Generally, it is clear that vegetative growth was affected with size of peepers used in the experiment. Plants in the first season were smaller than those of the second one. So, the vegetative growth in the second season was more vigorous than that of the first one. However, it is observed that removing reducing, or increasing magnesium in the nutrient solution did not affect vegetative growth as compared with that of standard nutrient solution.

It was hard to find similar work dealing with banana plants grown in sand culture. However, Turner and Barkus (1981) found that magnesium deficiency had little effect on growth of "Williams" banana grown under field conditions.

Hobbs (1944) and Leonard *et al*. (1948) found that minus or low levels of magnesium in the nutrient solution reduced height, stem diameter and dry weight of pine and sweet potatoes plants grown in sand culture.

Table (1): Effect of different levels of magnesium on vegetative growth of "Hindy" banana plants grown in sand culture during two seasons.

Treatments		Pseudostem Height (cm)	Pseudostem Girth (cm)	No. of green leaves/ plant	Third upper leaf Length (cm)	Third upper leaf Width (cm)	Area (cm^2)
Mg* %	in nutrient solution (ppm)						
1988 season							
0	zero	27.5a	11.8 a	12.0 a	36.8 a	18.8 a	692 a
50	18	27.5 a	12.8 a	11.5 a	36.8a	18.5 a	681 a
(S.N.S.)	36	25.8 a	12.8 a	11.3 a	36.0 a	17.5 a	630 a
200	72	27.3 a	13.3 a	11.8 a	38.3 a	17.5 a	670 a
300	108	26.8 a	13.5 a	11.0 a	39.5 a	18.0 a	711a
1990 season							
0	zero	31.0 a	11.3 b	8.5 a	46.8 a	23.0 ab	1076 ab
50	18	33.8 a	12.3 ab	7.3ab	44.5 a	20.5 b	912 b
(S.N.S.)	36	34.3 a	13.0 ab	6.3 b	49.5 a	23.3 ab	1153 ab
300	108	40.5 a	14.0 a	7.5 ab	55.8 a	22.8 ab	1272 a
600	216	36.3 a	14.0 a	8.5 a	49.8 a	24.5 a	1220 a

*Mg % relative to Mg in the Standard Nutrient Solution(S.N.S).
Mean separation within column in each season by Duncan's multiple range test, 5% level.

Visual symptoms:

Although plants were subjected to different levels of magnesium from August until November (about 4 months), they appeared healthy specially the third leaf from the top of the plant which was selected as a recommended sample for determination. However, it was observed at the same time (the end of the growing season) that removing or reducing magnesium from the nutrient solution affected the appearance of the oldest leaf at the base of the pseudostem of some plants. In this case, a very limited area at the tip or margin of the blade appeared chlorotic or burned. Oldest leaves of other treatments (standard nutrient solution and those supplied with higher levels of magnesium) did not show such symptoms and remained healthy.

Therefore, it is clear that removing or decreasing magnesium from the nutrient solution did not affect the growth of banana plants at the end of the season, but it was observed that the oldest leaf at the base of the pseudostem showed very limited area of chlorosis.

The pale green colour caused by magnesium deficiency is usually most pronounced in the older leaves because magnesium is mobile in the phloem and readily redistributed within the plant (Bukavac and wittwer, 1957).

Leaf mineral content:

Nitrogen:-

In the first season (Table 2) N content in the leaves was not affected significantly by removing, reducing or increasing magnesium in the nutrient solution. However, increasing magnesium in the nutrient solution up to 300% increased N content in the leaves significantly compared with that of (S.N.S.) treatment or any other treatments.

In the second season (Table 2) the values of N content in the leaves were higher than those of the first season. However, removing, reducing or increasing magnesium in the nutrient solution did not affect the content of N in the leaves as compared with that of (S.N.S) treatment. However, more increase in magnesium (600%) in the nutrient solution slightly increased N content in the leaves compared with that of (S.N.S.) treatment.

From the above results of the two seasons, it could be concluded that N content in the third leaf from the top of "Hindy" banana plants supplemented with standard nutrient solution ranged between 2.11-2.60%. Removing, reducing or increasing magnesium in the nutrient solution did not affect N content in the leaves significantly but excess of magnesium in the nutrient solution increased N content significantly in the first season only.

It was hard to find similar work dealing with banana plants grown in sand culture. However, Smith *et al*. (1954) found that low magnesium in the nutrient solution increased N content in leaves of "Valencia" orange trees grown in sand culture.

Phosphorus:

In the first season (Table 2) results indicated that reducing or removing magnesium from the nutrient solution increased P content in the leaves significantly as compared with that of (S.N.S.) treatment. On the other hand, increasing magnesium by 200% in the nutrient solution had no significant effect on P content in the leaves but more increase in magnesium (300%) in the nutrient solution increased P content in the leaves significantly than those of (S.N.S.) treatment.

In the second season (Table 2), it is clear that P content in the leaves was lower than that of the first one. Removing or reducing magnesium from the nutrient solution increased P content in the leaves significantly when compared with that of (S.N.S.) treatment. On the other hand, increasing magnesium by 300% in the nutrient solution induced no significant decrease in P content in the leaves compared with that of (S.N.S.) treatment. More increase in magnesium (600%) in the nutrient solution increased P content in the leaves significantly than those of 300% or (S.N.S.) treatments.

Therefore, it could be concluded that P content in the leaves of young "Hindy" banana plants supplemented with standard nutrient solution ranged between 0.16- 0.27%. Moderate reduction or increase in magnesium in the nutrient solution increased P content in the leaves slightly but removing or excess of magnesium in the nutrient solution induced a significant increase in P content in the leaves.

It was hard to find similar work dealing with banana plants grown in sand culture. However, Smith *et al*. (1954) found that the low or higher levels of magnesium in sand culture decreased P content in leaves of "Valencia" orange.

Potassium

In the first season (Table 2), removing or reducing magnesium in the nutrient solution increased K content in the leaves slightly but not significantly when compared with that of (S.N.S.) treatment. On the contrary, increasing magnesium in the nutrient solution by (200%) tended to increase K content in the leaf slightly but not significantly than that of (S.N.S.) treatment. More increase in magnesium (300%) in the nutrient solution increased K content in the leaves significantly as compared with that of (S.N.S.) treatment.

In the second season (Table 2), it is clear that K content in the leaves was higher than that of the first season. However, decreasing or increasing magnesium in the nutrient solution did not affect K content in the leaves significantly. Nevertheless, removing magnesium from the nutrient solution increased K content in the leaves significantly compared with any other treatments except S.N.S. treatment.

Generally, It could be concluded from the results of the two seasons that K content in leaves of " Hindy" banana plants supplied with standard nutrient solution ranged between 1.74- 3.19%.

Reducing or increasing magnesium in the nutrient solution showed contradicting effects on K content in the leaves.

In this respect, Lineberry & Burkhart (1943) and Smith *et al*.(1954) found that lack or low of magnesium in the nutrient solution increased K content in leaves of strawberry and " Valencia" orange grown in sand culture.

Table (2): Effect of different levels of magnesium on some macronutrients in leaves of "Hindy" banana plants grown in sand culture during two seasons.

Treatments		Percent in dry matter					
Mg* in nutrient solution %	(ppm)	N	P	K	Ca	Mg	Na
1988 season							
0	zero	2.13 b	0.44 a	1.77 b	1.16 a	0.43d	0.08 b
50	18	2.06 b	0.39 ab	1.80 ab	1.23 a	0.57 c	0.10 a
100 (S.N.S.)	38	2.11 b	0.27b	1.74 b	0.92 b	0.76 b	0.10 a
200	72	2.10 b	0.32 b	1.90 ab	1.10 a	0.82 ab	0.09 ab
300	108	2.28 a	0.42 a	2.00 a	0.83 b	0.89 a	0.09 ab
1990 season							
0	zero	2.66 a	0.24 a	3.45 a	2.12 a	0.60 c	0.075 a
50	18	2.80 a	0.22 a	2.99 b	2.21 a	0.69 c	0.072 a
100 (S.N.S.)	36	2.60 a	0.16 b	3.19ab	1.79 b	0.82 b	0.072a
300	108	2.57 a	0.14 b	2.90 b	1.75 b	0.83 b	0.068 a
600	216	2.68 a	0.22 a	2.90 b	1.79 b	0.94 a	0.070 a

*Mg % relative to Mg in the Standard Nutrient Solution (S.N.S).
Mean separation within column in each season by Duncan's multiple range test, 5% level.

Calcium

In the first season (Table 2), results indicated that reducing, removing or increasing magnesium in the nutrient solution increased Ca content in the leaves significantly as compared with that of (S.N.S.) treatment. On the other hand, more increase of magnesium in the nutrient solution had no significant effect on Ca content in the leaves compared with that of (S.N.S.) treatment.

In the second season (Table 2), it is observed that Ca content in the leaves was higher than that of the first season. However, Ca content in the leaves was significantly increased by reducing or removing magnesium from the nutrient solution when compared with that of (S.N.S.) treatment. Increasing magnesium (300% and 600%) in the nutrient solution had no significant effect on Ca content in the leaves.

Consequently, it could be concluded from the results of the two seasons that Ca content in the leaves of " Hindy" banana plants supplied with standard nutrient solution ranged between 0.92- 1.79%. Decreasing or removing magnesium from the nutrient solution increased Ca content in the leaves. Increasing magnesium in the nutrient solution did not affect Ca content in the leaves.

These results are in agreement with those obtained by Lineberry & Burkhart (1943) and Smith *et al.* (1954) who found that lack or low of magnesium in the nutrient solution increased Ca content in leaves of strawberry and "Valencia" orange grown in sand culture.

Leonard *et al.* (1948) and Madhok & walker (1969) found that increasing magnesium in nutrient solution increased Ca content in shoots and vines of strawberry and sunflower plants.

Magnesium:

In the first season (Table 2), reducing magnesium by 50% in the nutrient solution decreased Mg content in the leaves significantly than that of (S.N.S) treatment. Removing magnesium from the nutrient solution reduced Mg content in the leaves significantly and severely than those of (50% Mg) or (S.N.S) treatments. On the contrary, increasing magnesium by 200% in the nutrient solution had no significant effect on Mg content in the leaves. More increase in magnesium (300 %) in the nutrient solution induced a significant increase in Mg content in the leaves as compared with that of (S.N.S) treatment.

In the second season (1990), it is observed that Mg content in the leaves was slightly higher than that of the first one. However, reducing or removing magnesium from the nutrient solution decreased Mg content in the leaves significantly as compared with that of (S.N.S.) treatment. On the other hand, increasing magnesium in the nutrient solution by 300% had no effect on Mg content in the leaves. Excess of magnesium (600%) in the nutrient solution increased Mg content in the leaves significantly as compared with that of (S.N.S.) treatment.

Therefore, it could be concluded from the results of the two seasons that Mg content in the leaves ranged between 0.76-0.82% when plants were supplied with the standard nutrient solution.

Removing magnesium from the nutrient solution reduced Mg content in the leaves and when Mg content in the leaves attained (0.43-0.60%), it means a lack of magnesium and plants are in need to magnesium supply. However, the gradual increase in magnesium in the nutrient solution, gradually increased Mg content in "Hindy" banana leaves. When magnesium existed in excess in the nutrient solution, the percentage of Mg in the leaves attained 0.94%.

These results are in agreement with those obtained by Lineberry & Burkhart (1943) and Smith *et al.* (1954) who found that lack or low of magnesium in the nutrient solution reduced Mg content in leaves of strawberry, and "Valencia" orange in sand culture.

Leonard *et al.* (1948) and Madhok & Walker (1969) found that Mg content was increased in shoots and vines of sweet potatoes and sunflower plants with increasing magnesium in nutrient solution.

Sodium:

In the first season (Table 2), removing magnesium from the nutrient solution decreased Na content in the leaves significantly when compared with that of (S.N.S.) treatment. Reducing or increasing magnesium in the nutrient solution did not affect Na content in the leaves significantly.

In the second season (Table 2), it is clear that Na content in the leaves was lower than that of the first season. However, Na content in the leaves was not significantly affected by removing, reducing or increasing magnesium in the nutrient solution as compared with that of (S.N.S) treatment.

Generally, it could be concluded from the results of the two seasons that Na content in the third leaf from the top of "Hindy" banana plants supplied with standard nutrient solution ranged between 0.072- 0.10%. However, reducing or increasing magnesium in the nutrient solution had no significant effect on Na content in the leaves.

It was hard to find similar research work dealing with banana plants grown in sand culture. However, Smith *et al.* (1954) and Madhok & Walker (1969) found that low magnesium in the nutrient solution increased Na content in leaves of "Valencia" orange and sunflower plants in sand culture.

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" تأثير المستويات المختلفة من المغنسيوم علي النمو الخضري ومحتوي العناصر الغذائية لنباتات الموز الهندي النامية في مزرعة رملية "

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أجريت هذه الدراسة علي نباتات الموز الهندي النامية في مزرعة رملية لدرسة تأثير المستويات المختلفة من المغنسيوم في المحلول الغذائي علي النموالخضري والعناصر الغذائية.

لم يتأثر النمو الخضري معنوياً بالمستويات المختلفة من المغنسيوم.

ادي ازالة أو نقص المغنسيوم من المحلول الغذائي الي ظهور مناطق مصفرة أو محروقة فى طرف وحواف الأوراق الكبيرة السن الموجودة على قاعدة الساق الكاذبة.

عندما تراوح محتوي المغنسيوم بالورقة الثالثه من اعلي النبات ما بين 0.43-0.60% كان دليلا علي احتياج النبات للمغنسيوم في حين تراوح محتوي الاوراق من المغنسيوم ما بين0.76-0.82% للنباتات التي عوملت بالمحلول الغذائي القياسى وعند زيادة المغنسيوم في المحلول الغذائي زادت نسبة المغنسيوم بالاوراق ما بين 0.89-0.94% ومن ناحية أخرى أدي ازالة او نقص المغنسيوم من المحلول الغذائي الي زيادة الفوسفور والكالسيوم ونقص المغنسيوم في حين لم يتأثر النتروجين بينما ادت زيادة المغنسيوم في المحلول الغذائي الي زيادة النتروجين والفوسفور والمغنسيوم في حين لم يتأثر كل من البوتاسيوم والكالسيوم والصوديوم.