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YIELD RESPONSE OF THE RED SPANISH PINEAPPLE IN PUERTO RICO AS AFFECTED BY DIFFERENT LEVELS OF MAGNESIUM

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INTRODUCTION

Nutritional work carried out with magnesium and trace elements on pineapples in Puerto Rico in a Río Lajas sandy clay, a potential soil for pineapple growing, pointed out that magnesium was the only nutrient which greatly favored plant growth and which influenced significantly yields (3). For both the plant and ratoon crops, magnesium-treated plants produced 54 percent more fruit weight per acre than plants not supplied with this nutrient. Further research work with the above mentioned nutrients on pineapples grown in a Bayamón sandy clay, the most extensively used acid lateritic soil for pineapple growing in the Island, brought out similar results (4). Magnesium-treated plants produced on the average, 2.7 tons more fruit per acre than the check plants.

This paper reports more data on additional magnesium studies with pineapples.

MATERIELS AND METHODS

Two experiments were initiated in the autum at two different sites in the northern part of the Island, near Arecibo. The experiments were established in Bayamón sandy clay, an acid deep lateritic soil of the coastal plain derived from limestone and typical of the pineapple growing region (6).

Plots were 18 × 6-3/4 feet, with an area of approximately 1/359th of an acre. On each plot 2 rows of pineapples were planted, 12 plants to the row.

The experiments followed a paired plot design with 7 treatments and 6 replications. They were established to study the effect of different quantities of magnesium sulfate ($MgSO_4 . 7 H_2O$) applied to the soil on yields of pineapples. Rates of magnesium sulfate used per acre ranged from 75 to 1 200 pounds. A magnesium chelate treatment at the rate of 100 pounds of this organic compound per acre was also included in the first experiment. Nutritional sprays of magnesium sulfate at the rate of 15 pounds of

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the salt per 100 gallons of water were also included as one of the differential treatments in the second experiment. Pineapple plants in all treatments were supplied with adequate amounts of NPK as soil application.

Two set of leaf samples were taken from representative plants in the replicated plots of each treatment of one of the experiments for chemical determination of magnesium to determine possible correlation between leaf nutrient content and yields. Leaf samples were taken when plants attained an age of 5 and 9 months, respectively. The active or largest leaf was selected for this purpose (7).

Flower induction in the pineapple plants in both experiments was achieved by treating the crown of the plant with acetylene approximately 1 year after the experiments began.

When the plants were approximately 18 months old, the fruits were harvested as is usually done in commercial pineapple fields. The criteria used in evaluating the effect of the treatments were the weight and amount of marketable fruit, yields per acre, and leaf-magnesium content. Magnesium determination was ascertained by Parks *et al.* procedure (5). The data presented in this paper underwent statistical analyses.

RESULTS AND DISCUSSION

Plant Growth

Growth made by plants supplied with magnesium was far superior to that made by plants not supplied with this nutrient. This superiority in growth was more striking in plants which received rates of magnesium above 300 pounds or above per acre. The magnesium-treated plants were more vigorous and greener in color than the check or untreated ones. Some magnesium deficiency symptoms were noticed in leaves of these last group of plants which were similar to those reported elsewhere (2).

Fruit Yields

Results on the influence of magnesium on mean fruit weight and mean yield of fruit per acre are presented in table 1. The yield data for the crop of Experiment No. 1 show that significantly heavier fruit yields were obtained from the plots receiving magnesium sulfate at the various soil rates used per acre as well as from magnesium chelate than from the check plots or plots not supplied with magnesium (treatment 7). Table 1 also show that among all the magnesium-treated plants, those receiving 300 and 600 pounds of the salt per acre were the heaviest yielders. Their yields were significantly superior to those of plants receiving the two lowest and the highest rates of magnesium sulfate per acre (treatments 1, 2 and 5). Also they were significantly superior in yields to the plants supplied with magnesium chelate at the rate used.

Table 1 also shows the mean fruit weight and mean yield of fruit to the acre for the crop of Experiment No. 2. The results from this experiment further confirm those obtained in the previous experiment except that in this case among the plants supplied with magnesium, those which received 300 pounds of magnesium sulfate per acre were the heaviest yielders, their yields being significantly superior to those of plants receiving the two lowest rates of the salt per acre. It can be seen also from table 1 that

TABLE I

Effect of magnesium on pineapple yields in Bayamón sandy clay at two locations, Arecibo, P. I. ([1])

Treatment No.	Description of treatments	Mean weight of fruit	Mean yield of fruit per acre	Outyielded at .05	Outyielded at .01
	Experiment No. 1				
		Pounds	*Tons*		
1	$MgSO_4$, 75 lbs per acre	3.46	14.91	—	7
2	$MgSO_4$, 150 lbs per acre	3.61	15.55		7
3	$MgSO_4$, 300 lbs per acre	3.90	16.80	1, 2, 5, 6	1, 7
4	$MgSO_4$, 600 lbs per acre	3.97	17.10	1, 2, 5, 6	1, 7
5	$MgSO_4$, 1 200 lbs per acre	3.65	15.72	—	7
6	Mg chelate, 100 lbs per acre	3.67	15.81	—	7
7	Check-NPK only	3.18	13.70		
	Experiment No. 2				
1	$MgSO_4$, 75 lbs per acre	3.80	16.37	7	—
2	$MgSO_4$, 150 lbs per acre	3.87	16.67	7	—
3	$MgSO_4$, 300 lbs per acre	4.35	18.74	1, 2	7
4	$MgSO_4$, 600 lbs per acre	4.20	18.09	7	—
5	$MgSO_4$, 1 200 lbs per acre	3.89	16.76	7	—
6	$MgSO_4$, sprays ([2])	4.15	17.88	7	—
7	Check NPK only	3.41	14.69	—	—

([1]) Commercial fertilizer (13.3.12) was applied in all treatments at the rate of 20 cwt per acre distributed in 3 applications.

([2]) Plants receifed 3 foliar sprays at the rate of 15 lbs $MgSO_4.7H_2O/100$ gallons H_2O.

magnesium sulfate foliar sprays were also responsible for increasing significantly fruit yield per acre. The effect of the various soil magnesium treatments on the combined yields of both experiments is graphically shown in figure 1, together with the percentage increase in yield (black bar) in favor of plants treated with magnesium when compared to the check plants or plants not supplied with magnesium.

Leaf Magnesium and Regression Studies

Table 2 shows the results of magnesium determination in the active or largest leaf in 5-month and 9-month old pineapple plants, supplied or not supplied with magnesium, together with their corresponding yields. From the data presented it appears that there is a clone relationship between leaf magnesium and yield. Capó's mathematical equation, $Yr = A + B$ arc-tanpercent Nu (1) used andex plained in a previous paper (3) was tried once more in an effort to explain the above mentioned nutrient-yield relation, on both 5-and 9-month old plants. The equation was fitted to 42 individual values the means of which are shown by treatments on table 2. The regression equation obtained relating yield and nutrient composition of the pineapple leaf in 5-month old plants is :

$$Yr = 33.239\,4 + 164.064\,3 \text{ (arc-tan-percent Mg)}.$$

TABLE 2

Relationship between pineapple yields and leaf magnesium content at two stages of plant growth

Treatment No.	Description of treatments	Mean yield fruit per acre	Leaf Mg content	
			5-month old plants	9-month old plants
	Experiment No. 2			
		Tons	*Percent*	*Percent*
1	$MgSO_4$, 75 lbs. per acre	16.37	0.29	0.15
2	$MgSO_4$, 150 lbs. per acre	16.67	.30	.16
3	$MgSO_4$, 300 lbs. per acre	18.74	.32	.20
4	$MgSO_4$, 600 lbs. per acre	18.09	.32	.19
5	$MgSO_4$, 1 200 lbs. per acre	16.76	.35	.19
6	$MgSO_4$, sprays	17.88	.32	.17
7	Check, NPK only	14.69	.24	.13

The statistical analysis of fitting this equation pointed out that the regression of relative yield on arc-tan-percent Mg was highly significant with a coefficient of determination of 28 percent.

For 9-month old plants, the regression equation obtained relating yield and nutrient composition of the pineapple leaf is :

$$Yr = 52.300\,4 + 177.357\,8 \text{ (arc-tan-percent Mg)}.$$

In this case, the statistical analysis of fitting the above equation revealed that the regression of relative yield on arc-tan-percent Mg was also highly significant with a coefficient of determination of 33 percent. Thus, a somewhat better correlation between leaf nutrient content and yield was attained with 9-month old plants. The linear relationships between arc-tangent-percent magnesium and relative yields of pineapple on 5-and 9-month old plants are illustrated graphically on figures 2 and 3.

CONCLUSIONS

The results that have been presented in this paper point once more to the need of incorporating magnesium in the fertilizer mix or using it as a nutritional spray so as to favor plant growth and development, and thus increase yields of pineapple on the acid Bayamón sandy clay, the most widely used soil type for commercial pineapple growing in Puerto Rico.

In regard to the correlation analyses between leaf magnesium content and relative yields, it may be also concluded that the percentage magnesium content of the pineapple leaf can be used as an index to predict the relative yield of pineapples.

SUMMARY

Two pineapple experiments were established in Bayamón sandy clay, the most extensively used acid lateritic soil for pineapple growing in Puerto Rico. The experiments were conducted to study the effect of different amounts of magnesium sulfate applied to

the soil on yields of pineapples. The influence of magnesium chelate and of foliar sprays of magnesium sulfate on pineapple yields was also studied. The results obtained are briefly summarized as follows :

1. Pineapple plants supplied with magnesium were more vigorous and greener in color than similar plants not supplied with this nutrient.

2. Significant heavier fruit yields were obtained from pineapple plants receiving magnesium sulfate at the various rates used as a soil application than from the pineapple plants not supplied with this nutrient.

3. Magnesium chelate and magnesium sulfate foliar sprays were also responsible for increasing significantly fruit yields per acre.

4. Highest fruit yields were associated with the highest nutrient contents of magnesium in the leaves.

5. Highly significant correlations were found between pineapple relative yields and leaf magnesium content at two crop ages.

6. Results indicate that magnesium content of 5-and 9-month old pineapple leaves can be used to predict relative crop yields.

Résumé

Effets de différents niveaux de magnésium sur le rendement de l'ananas red-spanish a Puerto Rico

Deux essais ont été étudiés sur les sols sablo-argileux acides (sols latéritiques, série de « Bayamón ») qui sont les plus généralement utilisés à Puerto Rico pour la culture de l'ananas. Les apports de magnésium ont consisté en : sulfate de magnésium appliqué au sol et en pulvérisation foliaire ; apport sous forme de chélate. Les principaux résultats obtenus sont les suivants :

1. Les plantes ayant reçu Mg sont plus vigoureuses et plus vertes.

2. Accroissement significatif du rendement (fruits plus gros pour toutes les doses de sulfate de magnésium utilisées).

3. Il en est de même avec les pulvérisations foliaires et le chélate.

4. Les meilleurs rendements correspondent aux teneurs les plus élevées de Mg dans la feuille.

5. Une forte corrélation existe entre les rendements relatifs et la teneur des feuilles en Mg à 2 périodes du cycle.

6. La teneur en Mg de feuilles prélevées à 5 et 9 mois peut être utilisée comme test de prévision de rendement.

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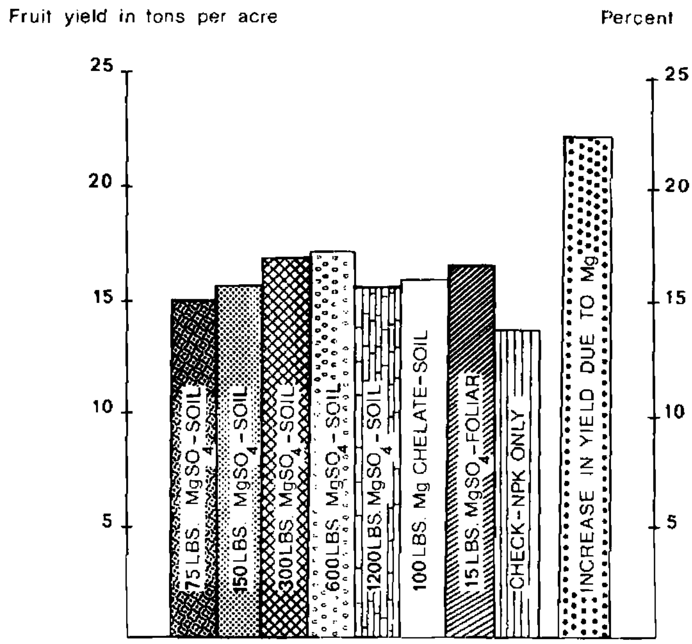

FIG. 1. — Pineapple yields as influenced by magnesium treatments when grown on a Bayamón sandy clay. Dark bar at right stands for percentage increase in yield in favor of plants supplied with magnesium as compared to plants not supplied with the nutrient.

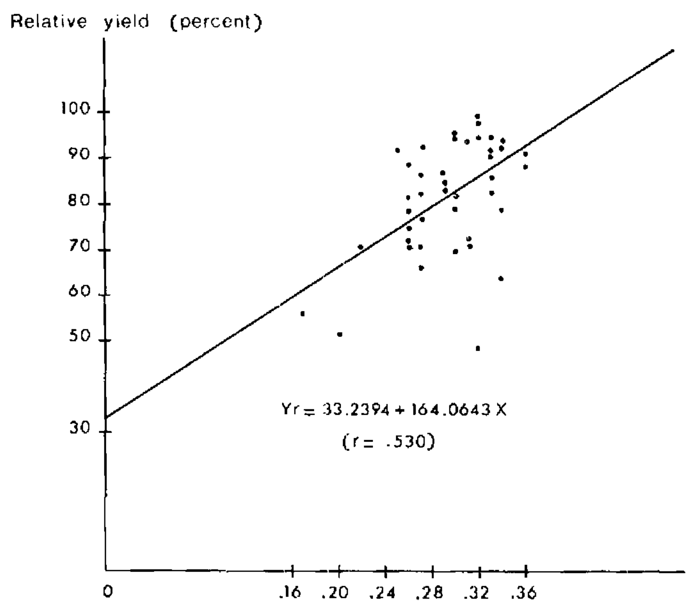

FIG. 2. — Arc-tan-percent magnesium (radians). Regression of relative yield of Pineapple on arc-tangent-percent magnesium as determined on 5 month old plants.

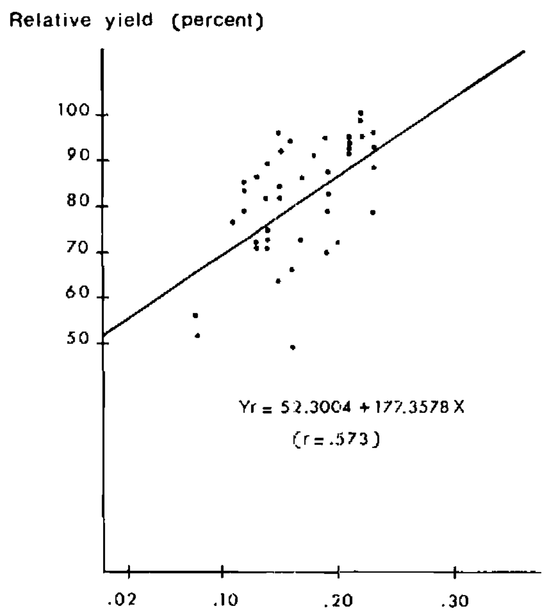

FIG. 3. — Arc-tan-percent magnesium (radians).
Regression of relative yield of Pineapple on arc-tangent-percent magnesium as determined on 9 month old plants.