

Extraction of N, P, K, Ca and Mg by cantaloupe plants (*Cucumis melo* L.) Packstar hybrid under Tarabana conditions, Lara state.

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Abstract

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Lara State is one of the largest cantaloupe farmers in Venezuela, thus the importance of determining the crop nutrient removal in order to program rational fertilizer practices. Cantaloupe plants hybrid Packstar were grown in Tarabana, Lara State, Venezuela, and N by microkjeldahl method, P by colorimetric analysis using ammonium-vanadate, K by flame photometry, Ca and Mg using atomic absorption spectrophotometry removal were determined based on plant dry weight and nutrient concentrations. The experiment was conducted as a randomized complete design with seven replications and five-plant plots. During harvest time, highest level of K, Ca and Mg were found in petioles while the lowest was found in lamina, root and ripe fruits, respectively. Highest level of N and P were found in lamina and ripe fruits whereas the lowest was found in roots. Total extraction of macronutrients were 75 kg N, 7 kg P, 64 kg K, 62 kg Ca and 10 kg Mg per hectare when 28,440 kg of fruits were harvested.

Key words: *Cucumis melo* L., Nutrition concentration. Foliar diagnostic. Nutrition

Introduction

The cantaloupe cultivars *Cucumis melo*, L), a fruit vegetable, has experimented a great development, being in the past a product of minority consumption to another one of ample acceptance (37). Lara state is one of the main producers with 10.400hg/ha, whose

potential is originated of its great area with a semi-arid climate (22). In the country the studies made on nutritional on melon aspects are few, although it is known that the plant is more demanding to the availability of macronutrients that other cucurbitaceae (10; 6). Therefore, is

important to define the levels of extraction of macronutrients on the part of the plant with the purpose to establish investigation lines to define fertilizer doses. In this sense, the amounts of required macronutrients must be considered on the bases of the development of the plant (24) and studies of calibration of soil analysis (15). Stanley (31) indicates that cantaloupe cultivars removes considerable amounts of nutrients of soil. For example, Gorski (11) found that to produce 15,000 kg of fruits until maturity 56 kg of N were extracted, 17 kg of P_2O_5 , 100 kg of K_2O , 70 kg Ca and 15 kg of Mg; nevertheless for these levels of

extraction the author does not specify the conditions of fertility of the soil nor the used variety. Between the main factors that condition the extraction of nutrients are the cultural combination of the genetic aspect and practices (23), age of the plant and the tissue (20), environmental temperature (5), light (30) and conditions of the soil such as humidity (7), salinity (1), acidity (19), aerate (17) and presence of toxic substances (35). The purpose of this research was to study the levels of extraction of N, P, K, Ca and Mg by cantaloupe plants in the Tarabana region, Lara state, under traditional handling conditions.

Materials and methods

The test was conducted between the months of February and May of 1999 at the Decanato de Agronomía of UCLA zone, located in Tarabana, Palavecino county, Lara state, located to 10° N and 510 01' m.s.n.m. The soil is formed by lateral contributions of the rivers Turbio and Claro and presents frank texture, moderate natural fertility (table 1) and one slope to 1%. Almost all the area belongs on a mount foot. The zone corresponds to a dry tropical forest (bs-T) according to the classification of the zones of life of Holdridge (12). According to the registries of the climatologic station (29), located within the experimental field, the precipitation average for 1998 was of 927 mm, with a regime of bimodal distribution. The first peak of maximum precipitation occurred in April and the second in October. The

annual average temperature is 26°C with maximum of 35.6 °C in April and minimum of 17.0 °C in January. The relative humidity average is 69%. The average of evaporation is 2102 mm/year with 7.9 hours/day of insolation. Cantaloupe hybrid Cantaloupe Packstar was cultivated into field conditions, of fruit widely adapted to the environmental conditions of the zone. The plants were lead under traditional conditions of handling, seeded in ridges to 1.50 ms of separation and 30 cm between plants (equivalent to 22,222 plants/ha), in a surface of 10m X 10m. furrow irrigation was used, incorporating by point of 10 sowing g of urea + organic fertilizer («fertipollo») later to the emergence and weekly fertilizations with the formula g/plant completes 12-24-12 at the rate of 30 g/plant. The control of weeds, plagues and diseases

Table 1. Analysis of the soil in the place of the test on stratus 0 -20 cm.

Sand	Limo	Clay	MO	P	K	Ca	Mg	pH	CE
	(%)				(mg kg ⁻¹)			(1:2)	(CE x 10 ⁵)
58	24	18	2	9	102	>3000	175	7.5	38

was made according to its incidence having used technical and products usually used by the farmers.

The test was conducted completely at random with seven replications where the experimental unit was constituted by five consecutive plants in a same row within the plantation. During the course of the experience the following variables were quantified:

Dry accumulation of matter.

A sampling of 35 plants was made to determine the humidity content discriminating each organ according to root, stem, leaves and fruits. The difference to reach the 100% represented the percentage of dry matter (DM). This value served to calculate the total of dry matter of the organs of all the plants of the test from its fresh or humid matters. The dry matter of each organ was obtained after putting under drying in stove of air forced to a temperature of 75°C during 24 hours. After obtained the different percentage from humidity average, the matter or dry matter in the plants remaining calculated using the formula:

$$M = MF (100 - \%H)/100$$

DM: dry matter.

FM: fresh matter

%H: percentage of humidity

Nutricional Levels. At the

time of the harvest the concentration of foliar of elements N, P, K, Ca and Mg. or it, after extracted the plants for the determination of dry matter, the nutricionales levels in each organ were evaluated. When it happened abortion of green fruits after the mincemeat, these also were incorporated to the analysis.

The used method to determine the nitrogen concentration was the microkjeldahl. For the other elements a humid extraction through nitric acids and perchloric was made. Then, each element was determined in the following form (14):

a.- Phosphorus, by colorimetry using vanadate of ammonium.

b.- Potassium, by flame photometry.

c.- Calcium and magnesium, by spectroscopy of atomic absorption, using a Perkin-Elmer equipment, model 2280.

Extraction of nutrients. From the concentration of nutrients and the dry matter of each organ of the plant, the total matter of nutrients extracted by the plant was determined during harvest. For this, the total efficiency by hectare based on the fresh matter and number of fruits harvested by plant was considered. In order to evaluate the different variables related to the accumulation from dry

matter and extraction of the plant the statistical program computerized COHORT (7) was used, version 4.21. The central tendency of the results

expressed by the average of the values and the dispersion through the standard deviation of the average.

Results and discussion

Percentage of dry matter (DM)

Average of 12.1% was at harvest time the main percentage of DM corresponds to the foliar lamina, followed by the buds with 9.7% and petiol 6.2% (figure 1); the smaller percentage of DM were observed respectively in the green fruits as much as the mature with values of 5.3% and 4.9%. The diminution of the percentage of dry matter observed in the mature fruits apparently are related to a dilution effect (9).

The results agree with the values of approximately 5% of DM in the fruits reported by Mallick and Masui (18). The distribution pattern of the proportion of dry matter in leaves agreed with reported by Tyler and Lorenz (32) for varieties PMR450,

Crenshaw, Honey Dew and Persian, and by Rincón *et al.* (28) for Toledo cultivar.

Concentration of nutrients Foliar Lamina

The content of nutrients in the foliar lamina at harvest time, expressed percentage on the base of dry matter in table 2. The concentration of N, P and K are in the ranks like low by Jones *et al.*, (14). This indicates that the amount of fertilizer is not adequate for the zone conditions. The Mg is located in the sufficiency rank and the Ca over the average (table 3). Considering the results of other authors as Locascio (15) and Piggott (25) the levels of K are low, whereas Ca values are high in comparison with all the reported. In this sense, it to emphasize that in

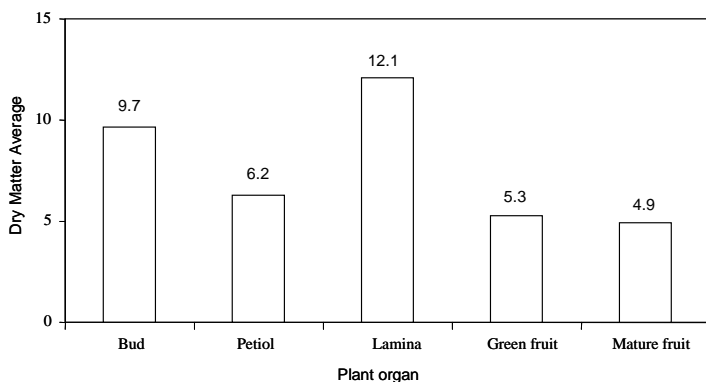


Figure 1. Average of dry matter into each plant organs of cantaloupe hybrid Packstar at harvest time

Table 2. Percentage of nitrogen, phosphorus, potassium, calcium and magnesium in the different organs from the hybrid melon plant Packstar at harvest time.

Organ	N	P	K	Ca	Mg
Lamina	3.8	0.21	1.5	5.3	0.63
Petiol	2.6	0.19	3.7	7.3	0.66
Buds	2.4	0.24	3.2	3.2	0.42
Mature fruits	3.3	0.43	3.5	1.0	0.35
Green fruits	3.2	0.37	3.0	2.2	0.33
Roots	2.1	0.1	1.6	1.8	0.23

another cucurbitacea, like the watermelon, it has been verified that the concentration of K in tissues can diminish and on the contrary by an increase in the concentration of Ca as a result of an antagonistic effect (16). Likewise, the Ca concentration has diminished due to the increased levels of N (4; 21). When comparing the concentration of nutrients of the plants under study with the values obtained in another zone of Lara state (table 3) in hybrid Araucano melon plants put under similar conditions of handling to the described for this study, it can be observed that the values of the studied plants are slightly below to the reported ones for that zone. These differences can be result of a varietal behavior or differences in the availability of nutrients for the plant. On the other hand and agreeing with the reported by Rincón *et al.*, (28) the greater concentration of N was in this organ, whereas the smaller concentration was in the roots, as it is observed in table 2.

Petiol

Table 2 shows the averages

values of the concentration of N, P, K, Ca and Mg in petiol during harvest. The N with 2.6 % is very below of the levels of sufficiency described by Gorski (11) for this organ of the plant (table 3). The P with a value of 0.2% and the K with 3.7% are in the level of sufficiency described by this author. On the other hand, for Ca and the Mg was not scientific investigation that it allowed to compare them at suitable nutricionales levels; nevertheless, Tyler and Lorenz (33) reported concentrations of Ca and Mg for melon plants of the varieties Cantaloupe, Crenshaw, Honey Dew and Persian that were between 2 and 4% and 0.5 and 0.8%, respectively, being able to observe that the concentration of Ca of this test is very over these results, whereas Mg this around them. The concentrations of these elements in peciolo fué superior to the concentration in the rest of the plant.

Buds

The concentration of N, observed Ca and Mg in the buds was smaller to the rest of the vegetative organs that include/understand the aerial part of the plant, whereas the P was

Table 3. Comparative values of tissue nutrients to cantaloupe foliar according to diverse authors

Nutrient (%)	Author				
	Piggott (1986) ¹	Jones (1991) ²	Locascio (1993) ³	Gorski (1989) ⁴	Data nonpublished by the author ⁵
N	2.0 - 3.0	4.09 - 5.00	2.5 - 5.0	0.4	4.0
P	0.25 - 0.40	0.25 - 0.6	0.2 - 0.6	0.2	0.3
K	1.8 - 2.50	3.59 - 4.5	2.0 - 6.0	4	2.0
Ca	5.00 - 7.00	2.59 - 3.2	1.0 - 2.0	-	8.9
Mg	1.00 - 1.50	0.35 - 0.8	0.3 - 0.6	-	0.8

¹In leaves of plants during harvest.

²In leaves of plants of *Reticulatus* groups and Honey dew at maturation time of the fruits.

³In completely active leaves and fruits in maturation.

⁴In petioles from 6th leaf at harvest time of the first fruits

⁵In leaves of plants hybrid Araucano at harvest time in Bobare region, Lara state.

greater with respect to those organs. Also, it is possible to be emphasized that the nutrients in greater proportion in this organ are K and Ca, followed of the N (table 2).

Green and maturity of fruits

The content of K and Mg was superior in the maturity of fruits with respect to the green ones, whereas the content of Ca was evidently in these last ones, as it is showed in table 2. The values obtained in this research are resembled to the reported by Tyler and Lorenz (32) in melon fruits PMR450 at 79 days posterior to seedtime; nevertheless, the reported values for Ca by these authors are very below of the obtained results with this research.

Roots

The content of N in the roots reported like of 2.1% was similar to the concentration presented by Tyler and Lorenz (32) as an average of four melon varieties. Also, it is observed that the content of this element in the roots was remarkably inferior with respect to the rest of the studied organs. The concentration of P, K and inferior Mg was inferior to the reported by the authors before mentioned, whereas C was superior. The high concentration of Ca in all the organs of the plants can be result that these were cultivated in soils with high content of this element, which promotes a luxury consumption, the plant continues absorbing Ca in amounts that exceed what requires for its optimal growth (34). This brings as a result an accumulation of the element in the plant without increase of any activity that involves

the Ca and therefore without increase of growth.

Extraction of nutrients

The nitrogen extraction by the different organs from the plants varied from 0.12 g/planta in petiole to 1.28 g/plant in the mature fruits (table 4). Also, well-known differences in the extraction for the different sampled organs were detected (figure 2). The main extraction was reached in mature fruit, in that order, by the foliar lamina, green fruit, root, petiole and sprout, which agrees with the results of Rincón *et al* (28) who found that the greater extraction of N made the fruits, followed by the foliar lamina and finally the stem. Nevertheless, the distribution pattern is different from the reported by Wilcox (36), Pire and Colmenárez (26), that observed greater extraction of nutrients in the stem than in the root in several olericols species. This can be attributed to the difficulty that there are in this type of study to accurately determine the dry matter of the roots because usually, into field conditions, it is not managed to extract the totality of the radical system. As it is shown in table 4 the extraction of phosphorus and potassium. In this sense it is possible to be observed that great differences as far as the extraction by the different organs exist (figures 3 and 4). In general, the extraction of both elements presents the same distribution pattern, which shows the greater amount of element extracted in the mature fruits and the minor for the petioles as far as P and the roots as far as K. The values showed in the

Table 4. Extraction of nitrogen, phosphorus, potassium, calcium and magnesium (g/plant) by the different organs from the hybrid cantaloupe plant Packstar at harvest time (average \pm standard deviation)

Organ	N*	P	K	Ca	Mg
Lamina	1.013 \pm 0.091	0.057 \pm 0.005	0.367 \pm 0.035	1.327 \pm 0.129	0.170 \pm 0.015
Petiol	0.115 \pm 0.014	0.008 \pm 0.001	0.169 \pm 0.020	0.321 \pm 0.028	0.030 \pm 0.003
Buds	0.219 \pm 0.019	0.021 \pm 0.002	0.281 \pm 0.024	0.290 \pm 0.032	0.036 \pm 0.003
Mature fruits	1.278 \pm 0.046	0.164 \pm 0.007	1.468 \pm 0.040	0.388 \pm 0.040	0.131 \pm 0.006
Green fruits	0.501 \pm 0.080	0.061 \pm 0.009	0.495 \pm 0.079	0.268 \pm 0.047	0.058 \pm 0.010
Roots	0.326 \pm 0.031	0.018 \pm 0.002	0.046 \pm 0.004	0.178 \pm 0.018	0.024 \pm 0.001
Total	3.452	0.329	2.826	2.772	0.249

*The data come from samples of 35 plants, with the exception of the green fruits that come from 33 plants

research and the greater extraction of these elements on the part of the fruits agrees with the reported thing by Rincón *et al.*(28) cantaloupe to cultivate Toledo under conservatory conditions. Of the total of P and K extracted by the complete leaf, the extraction of petiol represents 12.4% and 30.69% respectively. This factor could be important to consider when comparing these results with the obtained by other authors, who express their results on the base of the complete leaf. The behavior of the different organs from the plant as far as extraction of Ca and Mg is similar, since the greater extraction is observed in the lamina to foliar and the minor in the root (figures 5 and 6). In average the extraction of Ca made by the plant until the moment of the harvest was 61.33 kg/ha. Distributed in 6,5% in the roots, 9.8% in the green fruits, 10.5% in buds, 11.6% in the petiol, 14.1% in mature fruits and 47.5% in the lamina.

The extraction of Mg until the harvest was 10 kg/ha, distributed in 5,3% in the roots, 7.0% petiols, 8.0% in the buds, 12.9% in the green fruits, 28.9% in mature fruits and 37.8% in the foliar lamina. On the base of 22,222 plants/ha and an average production by plant of 1.28 approximately 28,440 kg to produce kg/ha of hybrid cantaloupe fruits Packstar until harvest, the plant extracted from soil a total of 75 kg of N, 7 kg of P, 64 kg of K, 62 kg of Ca and 10 kg of Mg. The total extraction of N is similar of (73 kg/ha) the reported by INPOFOS (12), but which was calculated for a production of 22,000 kg/ha. The high

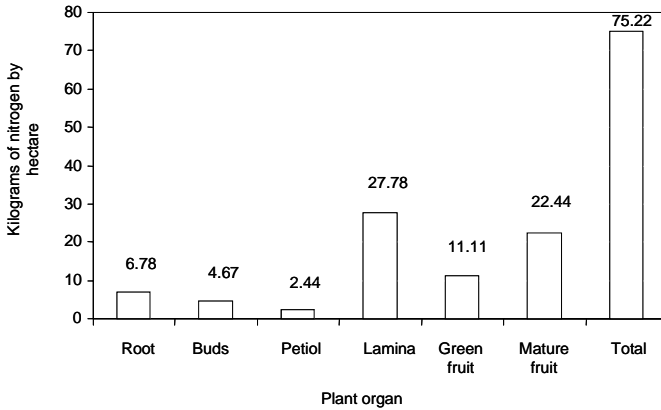


Figure 2. Extraction of nitrogen by different organs of cantaloupe plant hybrid Packstar at harvest time.

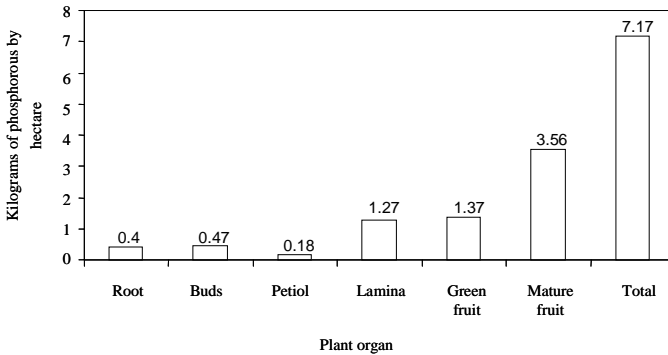


Figure 3. Extraction of phosphorous by the different organ plants of cantaloupe hybrid Packstar at harvest time.

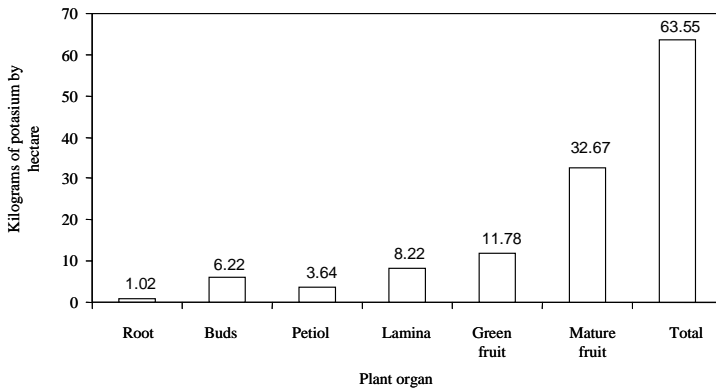


Figure 4. Extraction of potassium by the different plant organs of cantaloupe hybrid Packstar at harvest time

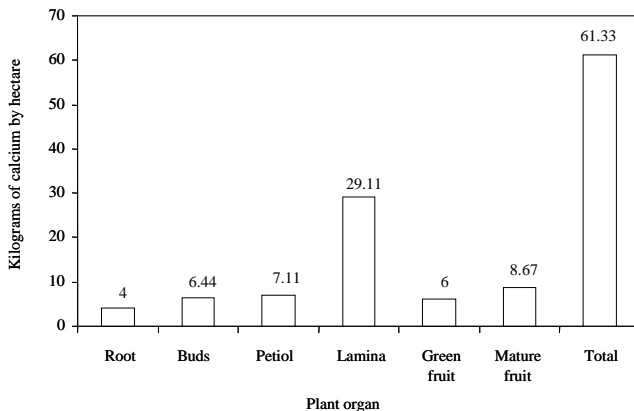


Figure 5. Extraction of calcium by the different plant organs of cantaloupe hybrid Packstar at harvest time

accumulation of N and K is associated with the effect that have these elements in promoting the development of the plants (27) and the growth and accumulation of sugars in the fruits (3, 28). Excepting the extracted amount of N, the values of

extraction of the P, K, Ca and Mg they are below the reported by 15,000 Gorski (11) to produce kg/ha of fruits, as well as of levels of extraction published by Bar-Yosef (2) for a 40,000 production of kg/ha.

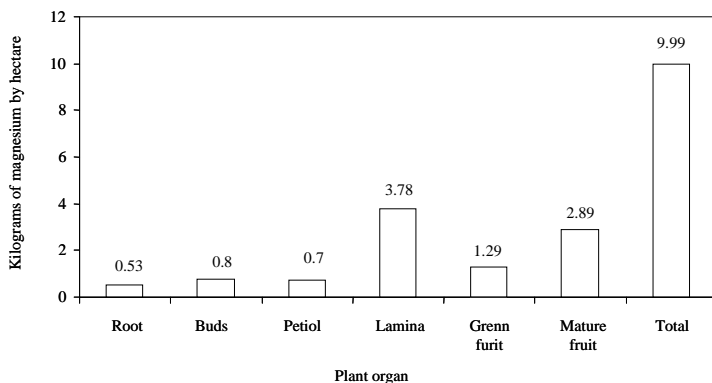


Figure 6. Extraction of magnesium by the different plant organs of cantaloupe hybrid Packstar at harvest time

Conclusions

At harvest time of the hybrid melon Packstar the main concentration of K, Ca and Mg was registered in petiol and the minors happened in the mature lamina, roots and fruits, respectively. The greater concentration of N registered in the lamina and P in the mature fruits, whereas the smaller concentration of

both elements was observed in the root. The N, K and Ca constituted the elements extracted in greater amount. Until the moment of the harvest, the plants with a production of 28,440 kg/ha of fruits managed to extract 75 kg of N, 64 kg of K, 62 kg of Ca, 10 kg of Mg and 7 kg of P.

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