



HARMFULNESS OF INSECTS OF THE FAMILY *Scarabaeidae* ASSOCIATED WITH GUAVA (*Psidium guajava* LIN.) PLANTATIONS

Nocividad de los insectos de la familia *Scarabaeidae* asociados a las plantaciones de guayabo (*Psidium guajava* Lin.)

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ABSTRACT. This research was conducted in the Basic Unit of Cooperative Production (UBPC) “Wilber Segura” belonging to the Empresa Agroindustrial Ceballos, in the period from 12 to 20 March 2012. The evaluated insects were the basis for determining the harmfulness of insects associated *Scarabaeidae* plantations guava (*Psidium guajava* Lin.) with the implementation of a management that ensures appropriate plant increased life and crop yield; for this the number of larvae that affect the root system of the plant and a diagnostic methodology was designed to assess the involvement caused by beetles was examined. The results show that there is a relationship between the number of larvae m⁻² in the root system of each plant, with symptoms manifested in leaf area compared to a loss of pigment chlorophyll and carotenoids increased. As you increase the degree of damage, increases the number of larvae m⁻², plants grade 0 reached three larvae/m², the grade 1 from 4 to 16 larvae m⁻², grade 2 from 17 to 30 larvae m⁻², grade 3 from 31 to 34 larvae m⁻² and grade 4 from 35 to 37 larvae m⁻². A increasing the degree of damage decreases the number of total and green leaves, and increases the number of leaves affected. The mass of roots branches and decreases as the number of larvae m⁻² increases.

RESUMEN. La presente investigación se realizó en la Unidad Básica de Producción Cooperativa (UBPC) “Wilber Segura”, perteneciente a la Empresa Agroindustrial Ceballos, en el período del 12 al 20 de marzo del año 2012. Los elementos evaluados sirvieron de base para determinar la nocividad de los insectos de la familia *Scarabaeidae* asociados a las plantaciones de guayabo (*Psidium guajava* Lin.) con la implementación de un manejo fitosanitario adecuado que garantice el incremento de la vida útil y rendimiento del cultivo; para ello se examinó el número de larvas que inciden en el sistema radical de la planta y se diseñó una metodología de diagnóstico para evaluar la afectación provocada por los escarabajos. Los resultados obtenidos demuestran que existe relación entre el número de larvas m⁻² en el sistema radical de cada planta, con los síntomas manifestados en el área foliar respecto a la pérdida de pigmentos de clorofila y aumento de carotenoides. A medida que aumenta el grado de afectación, incrementa el número de larvas m⁻², las plantas de grado 0 alcanzaron 3 larvas m⁻², las de grado 1 de 4 a 16 larvas m⁻², grado 2 de 17 a 30 larvas m⁻², grado 3 de 31 a 34 larvas m⁻² y las de grado 4 de 35 a 37 larvas m⁻². A medida que aumenta el grado de afectación disminuye el número de hojas totales y verdes, y aumenta el número de hojas afectadas. La masa de ramas y raíces disminuye a medida que se incrementa el número de larvas m⁻².

Key words: beetles, root eating insects

Palabras clave: escarabajos, insectos dañinos de la raíz

INTRODUCTION

Guava (*Psidium guajava* L.), is a plant very appreciated throughout the world for its delicious taste. It is native to tropical America with its center of origin between Mexico and Peru. In Cuba it existed already

since the discovery of America by the Spaniards (1). It is a fruit highly appreciated for being one of the most complete in nutrients, since its contents of vitamins A, B1 and B2 are high and vitamin C is twice as high as in orange; the levels of essential amino acids like tryptophan, lysine and methionine are very high. It is rich in tannins, as well as possessing properties such as intestinal astringent. Consumption as a fresh fruit is increasingly recommended by nutritionists and dietitians.

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Ciego de Avila province has set great goals; one of the most important is to increase the plan of development of fruit trees that includes this crop, mainly with the variety EEA 18-40 (Enana Roja Cubana) that has been planted mainly under the technology of propagation by cuttings. However, these plantations, which were initially expected to have a productive life of five years, have been greatly affected by pest attacks, causing them to not exceed three years (2). Among the pests that have contributed to the decline in crop production and its useful life are insects of the family *Scarabaeidae*, commonly called greyhounds, Galician or white worms, among others. However, the magnitude of the damages that these insects do in the plantations in general is not known exactly. Although in Sinaloa (Mexico) adults of *C. sinalo* have been observed feeding on guava fruits during the morning (3), the major affections occur in the roots and the damages are manifested in the foliage of the plants; (*Psidium guajava* Lin.) with the symptoms that are manifested in the anatomy of the crop under the conditions of the Ceballos Agroindustrial Company, for the implementation of an adequate phytosanitary management that guarantees the increase of the useful life and yield of the culture.

MATERIALS AND METHODS

The research was carried out at the "Wilber Segura" UBPC, located in the "Casualidad" farm, in the village of Ceballos, located at approximately 21 ° 56' North and 78 ° 44' West, in the municipality of Ciego de Ávila, Cuba, in the period from March 12 to 20, 2012, in guava plantations of the variety Enana Roja Cubana (EEA 18-40), in 4,78 ha in size, planted in January of 2009 on a Ferralitic Red soil, with a planting frame of 7,0 x 1,50 m for a population of 4551 plants.

To determine the effects of white worm larvae on guava (*Psidium guajava*, Lin), Enana Roja Cubana variety (EEA 18-40), a scale of five degrees was made by visual observation of the effects present in the foliage of the plantations of this cultivar in the experimental area, taking into account that the damages to the radical system of the crop modify its morphophysiology, provoking a symptom known as "guayabo rojo", "rosette leaf", "guayabo cenizo", "nematodes" among other denominations, where on the affected plants the shoots take a rickety appearance, the bark of the trunk and the branches become grayish and not removable (a healthy tree is peeled constantly as

it grows), with few vegetative growths and little or no growth production, the leaves become smaller and take a reddish color (4).

Taking these elements into account, the plants were placed on a five-degree scale:

Degree 0-plants with 100 % healthy leaves and green coloration.

Degree 1 - plants that have up to 25 % of the leaves affected and coloration varying between green -red, red and yellow.

Degree 2 - plants that have to 26 and 50 % of the leaves affected and coloration varying between green-red, red and yellow.

Degree 3 - plants that possess between 51 and 75 % of the affected leaves and coloration varying between red, red and yellow green.

Degree 4 - plants that possess more than 75 % of the affected leaves and coloration that varies between green red, red and yellow.

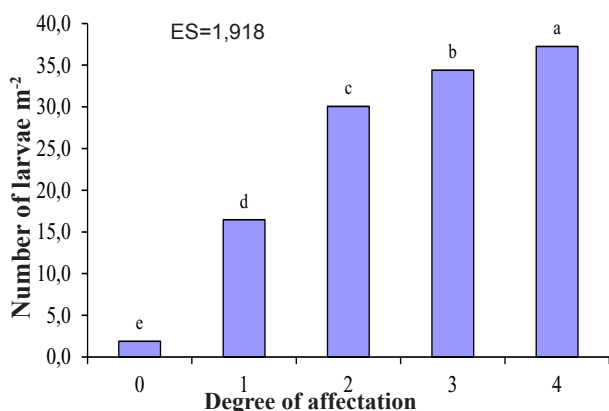
Ten plants of each degree were taken, homogeneously throughout the field, by the English Flag methodology, for a total of 50 and pits were made of 1 m² area, taking as a center the trunk of the plant, with a depth of 0.30 m and the larvae of insects of the family *Scarabaeidae* were collected, in bags of polyethylene, as well as the thick and thin roots present.

In each of the selected plants different anatomical parameters were evaluated, such as the total number of leaves per color scale (green leaves, red-green, red and yellow) in guava plants with different degrees of affection; The branch mass of the third level of the plants, placing the same ones of the trunk upwards, which were cut and collected in sacks and moved to the laboratories of chemistry and entomology of UNICA, where their mass was determined, by means of a balance Digital Mark Sartorius, for the thick branches and roots, as well as the mass of the fine roots, collected in the area of each soil pit.

RESULTS AND DISCUSSION

The total number of larvae m⁻² around the root system of the evaluated plants is shown in Figure 1, where it is observed that as the degree of affection increases in the guava plants, the number of larvae increases in each one, there were statistically significant differences between all treatments. It should be noted that in all evaluated plants, larvae were found at different depths, where those with a degree of affection could have up to 3 larvae m⁻², degree 1 larvae between 4 and 16 larvae m⁻², 17 to 30 m⁻² larvae, 3-degree larvae from 31 to 34 larvae m⁻² and in degree 4 larvae were found between 35 and 37 larvae m⁻² in the radical systems of the guava plantations.

In Mexico, the main factors that limit the productivity of guava orchards are, among others, the presence of pests such as *Cyclocephala lunulata* Burmeister, which has been found feeding on the fruits of the plant; However, these insects of the family *Scarabaeidae* are pests of many crops, in which large numbers of larvae can be found feeding on the radical system (5). In Mexico, these larvae may have densities that reach 600 larvae m⁻², in areas cultivated with sugar cane in the environs of Tepic, Nayarit, at 950 m of altitude, it has found averages of 0,2 to 47,5 larvae m⁻² with maximum of 51 larvae m⁻² (6) and produce losses that can be between 20 and 40 % (7), while in cassava and pastures densities of more than 8 larvae m⁻² were found, with a distribution in the form of patches (8).



Means with unequal letters differ according to Tukey ($p \geq 0.05$)

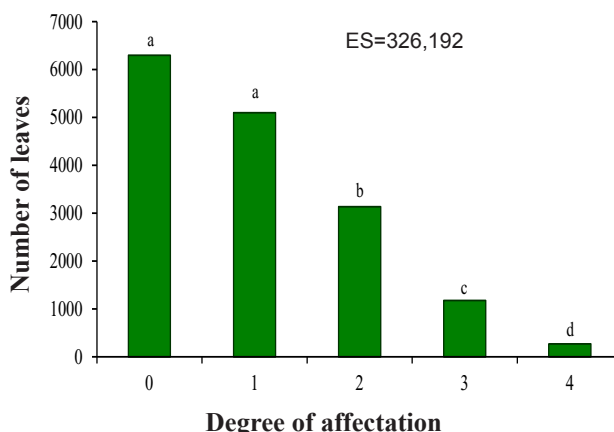
Figure 1. Total number of larvae found in the guava plants, in the different levels of affection, in the “Wilber Segura” UBPC, belonging to the Agroindustrial Company “Ceballos”

Usually, the larvae of white worm are numerous in the soils, being a complex where they agree diverse sorts and Coleoptera species; for example, nine genera and 41 Melolonthidae and Cetoniidae species have been registered in Mexico, which are associated with agave, tequila, alfalfa, amaranth, rice, peanut, coffee, squash, sugarcane, onion, jamaica, bean, bean (9, 10, 11, 12). In the guava plantations in the areas of “Wilber Segura” UBPC (according its acronyms in Spanish), insect adults of the Scarabaeidae family have been caught. Different genera and species which have different life cycles, but which in their larval stage coincide feeding on the root system of the crop, confirming that they have, for these conditions,

an ecological niche that allows them to reach high populations (13, 14).

Damages caused by large larvae of white worms, when fed on the roots of the coffee tree, can be large in nursery and coffee plantations, since adult plants have better capacity to recover from damage to newly transplanted plants in the field, a single larva may cause death (15).

When assessing the differences between the plants classified in each degree of affection, it was verified that there are marked differences in the number of leaves; according to the color scale it can be observed that the total number of green leaves corresponds to plants within degrees 0 and 1 with total values of 6300 and 5099 leaves respectively, without significant differences between them, but with respect to those of the Degrees 2, 3 and 4, with total values of 3137, 1176 and 270 green leaves respectively (Figure 2).



Means with unequal letters differ according to Tukey ($p \geq 0.05$)

Figure 2. Number of green leaves in guava plants with different degrees of affection, in the UBPC “Wilber Segura”, belonging to the Agroindustrial Company “Ceballos”

The number of red-green leaves increases as their degree of affection increases, according to the scale, so that plants in degrees 3 and 4 show the highest values, with 1139 and 1204 red-green leaves, respectively, with no differences among them, but with respect to the remaining degrees 0, 1 and 2, with values of 7, 417 and 986 green-red leaves for the third, which are significantly different among them. These results indicate that there is a directly proportional relationship between the degree of affection and the amount of red green leaves in the plants (Figure 3).

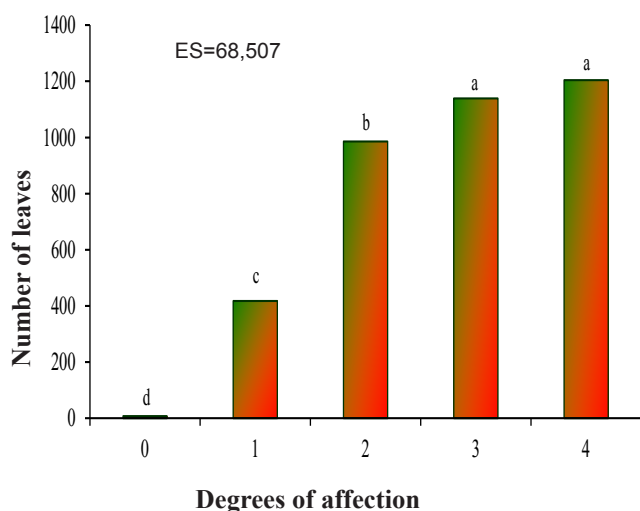


Figure 3. Number of red-green leaves in guava plants with different degrees of involvement in the “Wilber Segura” UBPC (according its acronyms in Spanish), belonging to the Agroindustrial Company “Ceballos”

Similar behavior showed the results when evaluating the number of red leaves for the plants in each degree of the scale, as it can be observed in Figure 4, where the number of red leaves in the plants increases in average that increases its degree in the scale, from values of 4 leaves to 843, with significant differences, except between plants of degrees 2 and 3.

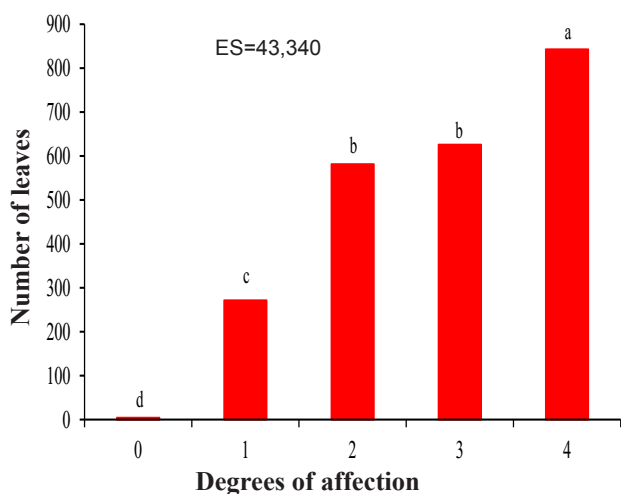


Figure 4. Number of red leaves in guava plants with different degrees of involvement in the “Wilber Segura” UBPC (according its acronyms in Spanish), belonging to the Agroindustrial Company “Ceballos”

Different, but in their larval stage, they feed on the root system of the crop, confirming that the in addition, in relation to the total number of yellow leaves of the plants evaluated in the different degrees of affection, a significant increase of values is observed, from plants with degree 0, with less than three yellow leaves, until the plants of degree 2, which reached the greatest number of yellow leaves (206,7), from which the number of yellow leaves decreases significantly, showing values of 172 and 87 leaves for the plants of the degrees 3 and 4, respectively (Figure 5).

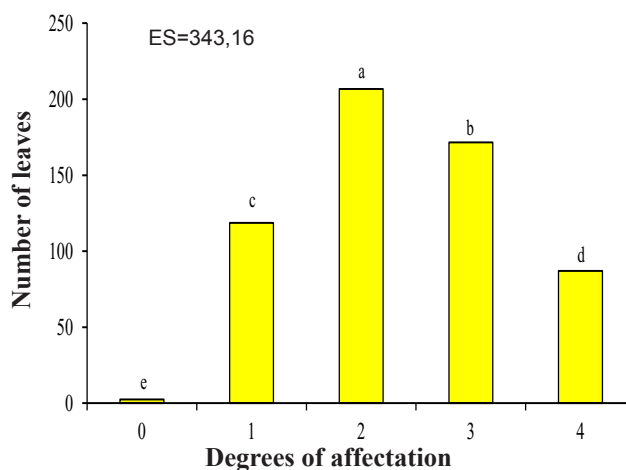


Figure 5. Number of yellow leaves in guava plantations with different degrees of affection in the “Wilber Segura” UBPC (according its acronyms in Spanish) belonging to the Agroindustrial Company “Ceballos”

The plants that suffer from water stress, manifest alterations that intervene directly in all the physiological processes of the same, mainly the photosynthetic, creating a mechanism so that its efficiency in the capture of sunlight does not diminish and begins to synthesize carotenoids, which are pigments of protection that accompany the chlorophyll pigments and act as an antenna in the process of capturing light and transfer of energy dissipated to the reaction center and that is where the plant leaf begins to take the colors (red and yellow). This phenomenon occurs when the plants suffer afflictions in the root system, reducing their capacity for water absorption and causing water stress, which causes, in the case of guava, a change in coloration in the leaves known as “Guayabo rojo “ (4). In addition, a significant decrease in the total number of leaves in the evaluated plants could be observed, as their position in the scale of affection increased, reason why the plants with degree 0 present greater number of leaves with a total of 6314, decreasing significantly from degree to degree 4 plants, which showed the lowest value with 2404 total leaves (Figure 6).

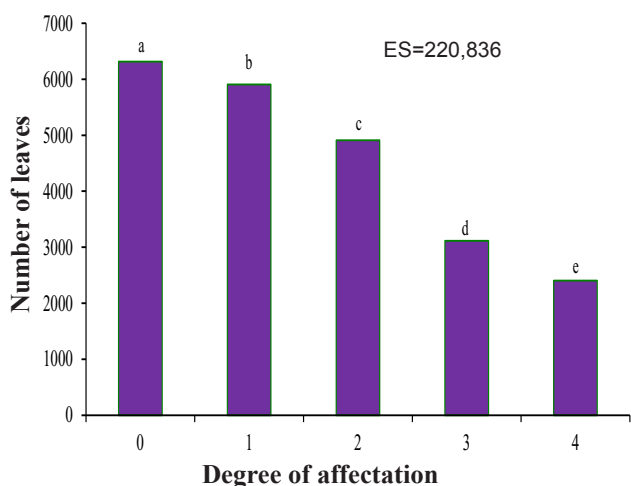


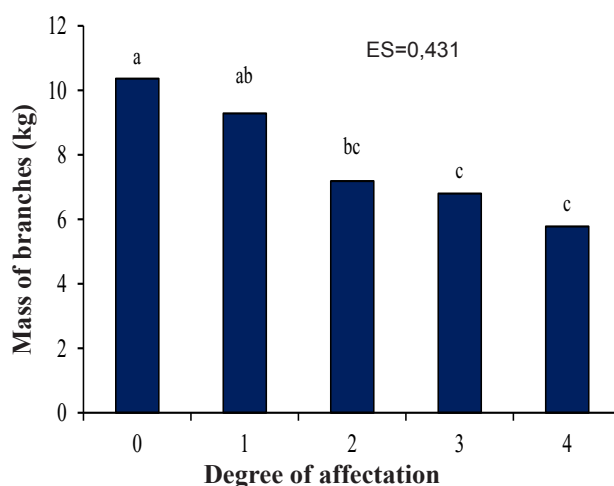
Figure 6. Total number of leaves in the different degrees of affection in guava plants at the “Wilber Segura” UBPC (according its acronyms in Spanish), belonging to the Agroindustrial Company “Ceballos”

In general, it is evident that as the degree of affection increases in the plants of guava, not only a change of coloration in the leaves that moves from the green to the yellow transiting through the green-red and red, but also that there is a gradual decrease in the total number of these, so that all the physiological and morphological processes of the plantations are greatly affected.

In plantations of coffee, both in the field and in storage, plants attacked by white worm or blind hen become opaque, withered, and yellowish and lose leaves, until they become dry in severe cases, since the damage in the roots prevents

When evaluating the mass of the branches of the third level the crop, obtained in the different degrees of affection, there is a tendency to show a lower mass as the degree of affection increases, observing the highest values in treatments 0 and 1 with 10,36 and 9,28 kg respectively, which were higher than those observed in plants with degrees of affection 3 and 4, with mass values of 6,80 kg and 5,78 kg, respectively (Figure 7).

This decrease in the mass of branches occurs due to the effects to the root system of the plant, by the action of the rhizophagus insects, which prevents the plant to absorb water and nutrients, causing a rickety appearance of the tree, changes in coloration in the bark of the trunk and branches, as well as decrease in the production of the plants (4)

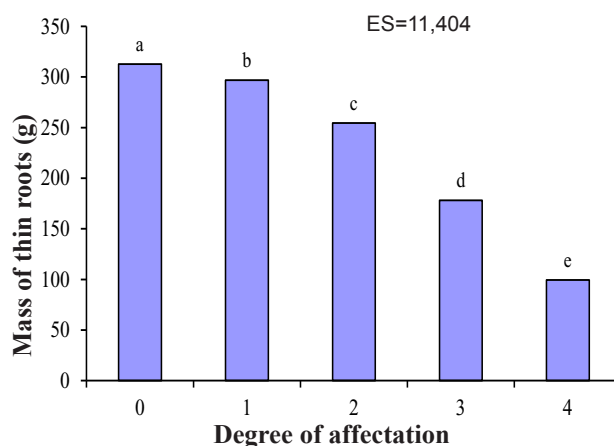


Means with unequal letters differ according to Tukey ($p \geq 0,05$)

Figure 7. Total mass of the branches obtained in guava plantations, in the different levels of affection in the UBPC (according its acronyms in Spanish) “Wilber Segura”, belonging to the Agroindustrial Company “Ceballos”

When evaluating the total mass of the fine and large roots, obtained in the guava cultivation in plants with different degrees of affection, it was observed that it increases significantly, as it decreases the degree of affection of the plants.

In the case of the fine roots, the plants of degree 0 presented greater mass of the roots with value of 312,66 g, whereas those of degree 4 presented a mass significantly lower, with 99,38 g. In the rest of the treatments, intermediate values ranging from 178,16 to 296,74 g (Figure 8) were obtained.



Means with unequal letters differ according to Tukey ($p \geq 0,05$)

Figure 8. Total mass of the fine roots of guava plants, with different degrees of affection in the “Wilber Segura” UBPC, (according its acronyms in Spanish) belonging to the Agroindustrial Company “Ceballos”

Meanwhile, the mass of thick roots also increased significantly from 1644,10 g in plants with degree 0 to degree 4 with a mass of 1000.93 g; while in degree 1, 2 and 3, values of 1506,03, 1427.02 and 1271,83 g, respectively were obtained (Figure 9).

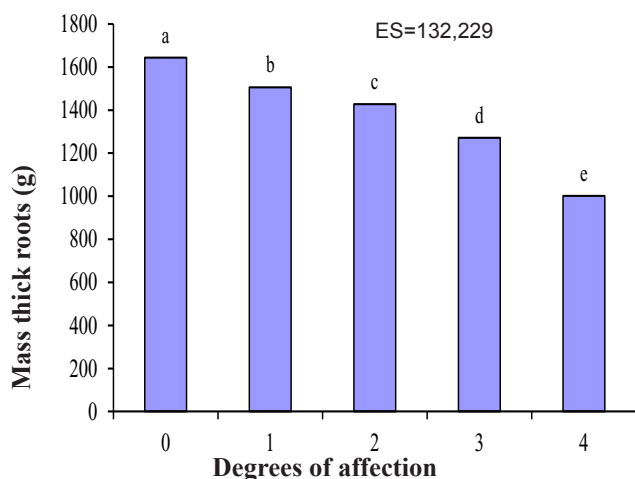


Figure 9. Total mass of the thick roots of guava plants, with different degrees of affection in the “Wilber Segura” UBPC (according to its acronyms in Spanish), belonging to the Agroindustrial Company “Ceballos”

The results indicate that the highest values of total root mass, both fine and thick, correspond to the treatment with a lower degree of affection (degree 0), which has the lowest number of larvae m^{-2} , in this case of 1 to 3 and apparently do not perform major damage to the roots of established plantations, while on the other hand, a gradual decrease of the total mass of plant roots appears, as the degree of affection increases.

White worms cause losses in many crops, consuming their root system, causing severe damage to crops in many countries, such as Mexico and others in Central America. In the case of corn cultivation, the damages can be between 0,4 and 1,3 t ha^{-1} per year (16).

When evaluating the resistance of several sweet potato clones (*Ipomoea batatas* (L.) Lam.), it was determined that the white worm larvae complex damages the root system of the crop when feeding on both the fine roots and the tuberous roots, decreasing the yields, none of the clones was more resistant than the control (17).

In the case of corn, the intensity of damage caused by pests of the root system, such as white worms, for a given year will depend on the number of larvae present, the size of the plant root system,

the availability of moisture and nutrients, the capacity of the plant to generate new roots and the climatic conditions (18).

The insect damages of the *Scarabaeidae* family are confined to the underground portion of the plants, reducing the water absorption, nutrients and also allowing the safe entry of other pathogens by the lesions they cause in the roots, which is why of assuming that the plants with greater degree of affection possess the radical system more damaged and, therefore, the mechanisms of absorption are difficult, provoking a stress situation that compromises its durability and quality of life.

The results allow us to confirm the relationship between the number of larvae m^{-2} in the root system of guava plants and the coloration change in the leaves (affectionation degree), aspects of great importance, and taking into account that in our country there are no methodologies for the diagnosis of beetles in the crop.

In plants such as the coffee tree attacked by blind hen in the roots, the absorption of water, nutrients and their physiological development in each organ of the root, mainly the roots, is impeded (15). Similar results were observed in maize cultivation, indicating that these plants in their initial stage are exposed to the attack of several pests, among them the blind hen (*Phyllophaga* spp.), causing serious damages such as loss of root mass and water stress to the plant, by feeding directly from the roots (18).

The research allowed determining elements that serve as a basis for the development of an appropriate management strategy, in a timely manner, based on a diagnosis using the practical method of visual observation, taking into account the relationship between the number of larvae m^{-2} found in the radical system of the guava plants of each affectionation degree and the anatomical-morphological characteristics of the plants (leaf quantity and color, third level branch mass and fine and thick roots) .

CONCLUSIONS

- ◆ There is a directly proportional relationship between the number of white worm larvae per m^2 associated with the roots of the guava plants and the affectionation degree manifested in the foliage.
- ◆ By increasing the degree of affection, the number of total and green leaves decreases, the number of red, green-red and yellow leaves increases, and the mass of the branches and roots of the guava plants decreases.

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