Rev. Fac. Agron. (LUZ). 2006, 23: 305-312

Defoliation effect caused by leaf-cutting ants (Formicidae:Attini) on cassava (*Manihot esculenta* CRANTZ) yield

M.V. Bertorelli[1], J. Montilla[1] y J. Hernández[2]

[1]Instituto Nacional de Investigaciones Agricolas (INIA-Anzoategui).
[2]Universidad Simón Bolivar, Biología de Organismos, Laboratrio de Comportamiento, Caracas, 1080A-Venezuela.

Abstract

Leaf-cutting ants cause severe damage in cassava crops especially in the plantation establishment phase; however, there is little information about the species that attack the crop and the effect on cassava yield. With the purpose of identifying leaf-cutting ants' species in the studied crop and their effect on the yield, 6 experimental plots of "Venezuela 7", a commercial clone, were established at INIA experimental field, El Tigre, Anzoátegui state, Venezuela. Two treatments were applied in the trial (treated plots with insecticides and no-treated plots) each with three replications. Insecticides were applied to all active nests, which were numbered and identified. The plots were evaluated every 21 days from June 2001 to May, 2002, and the number of damaged plant in each replication was registered. The results determined the presence of *Acromyrmex landolti* F., and *Atta sexdens* L. in the evaluated plots. From the total nest located in the non-treated plots 73% belongs to *Atta sexdens* species and 27% to *A. landolti*. *A. sexdens* was the most abundant in the studied area and the only one that caused defoliation in the crop. In relation to the number of damaged plants, significant differences between treatments were observed with a greater damage in the non-treated plots which caused 55% lost in the yield of the crop.

Key words: Leaf-cutting ants, *Atta*, yield, *Manihot esculenta*.

Introduction

Leaf-cutter ants have been considered as one of the most important pest in the agriculture on the neotropical region (4). In Venezuela, these ants commonly named as «bachacos» are widely known by the damages these occasion in different crops (3), for example, *Acromyrmex landolti* F., has been mentioned as one of the most abundant species of the oriental savannah and in the occident plain of Zulia state (8, 11). On the

Received November 4, 2004 ● Accepted September 13, 2005
Author email: mbertorelli@inia.gob.ve; marivi15@hotmail.com

oriental region, Hernández and Jaffé (16) have reported the presence of *Atta laevigata* Fr. Smith, *Atta sexdens* L. and *Acromyrmex landolti* F. Researches done about the economical damage caused by leaf-cutter ants in Venezuela are related to forest plantations according to the authors mentioned before. These authors say that *Atta laevigata* is the pest that most limits the establishment and development of Caribbean pine plantations in the south of Anzoátegui and Monagas states, finding that in less than ten years old pines, the volume of wood produced might reduce on even 50%, in areas with populations higher than 20 nets/ha. Other researches have demonstrated important losses in short-cycle crops, orchards, cropped pasture, forests and ornamental plants (4, 5, 6, 7, 8, 15, 17, 18). In cassava exists a huge variety of antropods from where at least 200 species have been identified, most of them are considered lower pest that cause minimal losses in yield; there is also a number of pest with an economic importance, some of these are the mites, the tobacco hornworm , the thrips, the fruit's flier and leaf-cutter ants (1).

In cassava, ants produce main problems in the establishment phase of the crop and its damage is mainly characterized by semi-circle cuts in leafs (2), nevertheless, there is few information about its effect in yields. Therefore, the aim of the research consisted on identifying the main species of leaf-cutter ants that attack the cassava crop and on determining the defoliation effect caused by this insect on the production of this crop.

Materials and methods

The research took place during the crop's cycle June 2001-May 2001; in lands of the National Institute of Agriculture Researches (INIA), located at El Tigre, Anzoátegui state, Venezuela, at 64º 12'56" of west longitude and 8º 51' 5" of north latitude and 267 msnm, with an annual temperature of 27ºC and a mean annual precipitation of 1036 mm. Soils of the area selected for the research are mainly sandy loamy. The activities done during this research are going to be described next:

Establishment of experimental plots

The genetic material employed for the crop's production of cassava was the clone Venezuela 7. 6 plots were established of 208 m^2 each, with 13 rows of 16 m of longitude, divided by 1m between them, on which plants were sowed with a separation of 1 m for a sow density of 10.000 plants.ha^{-1}.

Quantification, collection and identification of the leaf-cutter ants' species present on the area under study

The colonies of each of the leaf-cutter ants' species present on the area under study were market and numbered, and specimens of each of these were collected through representative samples in a forage gauge and active nets located in those areas and adjacent areas of these. The collected insects were put on vials of 4 ml of capacity which had ethylic

alcohol at 70%, where were kept until the moments of their taxonomic identification.

Damage evaluation and its effect on yield

With the aim of evaluating the differential of damaged plants (PD) by leaf-cutter ants and the damage effect on the crop's yield, 3 plots were treated with insecticide, denominating these as plots with control (PCC) and 3 without treatment, named as plots without control (PSC) or witness plots. The chemical control of the pest with insecticide consisted on applying using a sprayer of the commercial insecticide in powdered K-Othrine® 2P (Pyrethroid) to all colonies located in PCC in reason of 10 gr/m^2 of colony at a distance of 200 m around it. The area was kept under permanent observation, the activity of the colony was evaluated weekly as it was necessary to make a re-application of the insecticide using in this time the Blitz® fodder (phenyl pyrazole) in the same dose of the powdered insecticide, but in this case put on the active nets at the same doses of the previous one. On each plot, the percentage of damaged plants was determined, for this purpose 12 inspections were done every 21 days during the crop's cycle, counting the number of plants established on each of treatments and registering the damages occasioned by the insect under study. The averaged numbers of damaged plants on each treatment were compared through the statistical t Student test (10).

For the effect estimation of defoliation produced by leaf-cutter ants on the yield, 5 sub-areas were selected at random on each plot under the following plot design: randomized plots with sub-sampling (16), 2 treatments, 3 replications, 5 samples per replication evaluating the variables: a) Number of roots.plant^{-1} (average/sample), b) weight of roots in kg.plant^{-1} (average/sample), c) longitude of roots in cm (average of 5 roots on each sample), d) diameter of roots in cm, measured on the equatorial region of the root (average of 5 roots on each sample) and e) roots yield in kg.ha^{-1}, measured in based of the averaged weight of roots.plant^{-1} and the plants density on each sample.

The variance analysis was done according to the model shown before, meanwhile, the relation between the yield and the PD number was evaluated through the correlation coefficient test of Pearson (10) and the regression analysis with a significance level of $P<0.05$; employing the determination coefficient (r^2) to know if the model would adjust to a lineal, polynomial, exponential or logarithmic function (13).

Results and discussion

Quantification, collection and identification of the leaf-cutter ants' species present in the area under study.

The species evaluation of leaf-cutter ants present in plots under study and in areas near plots indicated that *Atta sexdens* L., and *Acromyrmex landolti* F., were the species present in the crop. *A. sexdens* is a species that characterizes by having formed nets by a central

conglomerate of mounds with numerous entrances and forage mouths or groups of these located in a concentric way around the central conglomerate of mounds. On the other hand, *A. landolti*, has colonies with lower size constituted by a variable-sized mound and an entrance formed by a tiny tower of approximately 2 cm of diameter and 5 cm of height and constructed with vegetal matter and particles of the soil. The small tower can branch off on its apical area in 1, 2 and even 3 entrances (11).

The quantification allowed to determine that from the total of nets located on plots and the areas around, 73% corresponded to *A. sexdens* specie and 27% to *A. landolti* specie.

In Venezuela *A. landolti* has been mentioned as one of the most abundant species in cattle areas of Zulia state and on the oriental savannah (6, 8, 12) and because of its exclusive habit of cutting and carrying leafs and recently sowed seeds of the Poaceae specie, it has been considered an important pest in pastures (8, 9, 14). It has been detected that this specie might cut and carry plants of other families in forced fasting conditions, as has been reported for Caribbean pine on the oriental savannah of Venezuela (16), however, in the present study was not observed this specie cutting as a vegetal substrate cassava plants.

Even though when *A. sexdens* was the most abundant specie in the studied plots, Hernández and Jaffé (6), have reported populations of *A. landolti* from 5 – 412 colonies/ha on the oriental savannah of Venezuela, and populations of incipient colonies of the same specie from 88 – 3044 colonies/ha, likewise, Lapointe *et al*. (9) found similar populations of this ant on Colombian savannahs. Of the *Atta* species detected on the oriental savannahs of Venezuela, *Atta laevigata* specie has been reported as the most abundant, reaching populations of even 60 colonies.ha^{-1} on Caribbean pines with high infection, but in *A. sexdens,* the lowest densities are presented and circumscribed to the adjacent areas of the water elements (6).

Damage evaluation and its effect on yield

In relation to the damage evaluation caused by ants in terms of PD number, in figure 1 are shown significantly statistical differences among means of PSC and PCC; observing highest values in PSC (151.5) compare to PCC (65.5) for all the evaluated dates according to the t test ($P<0.05$). It is highlighted the fact that *A. sexdens* was the only specie detected causing defoliation to the cassava crop.

In general, it can be observed that on PCC the number of damaged plants was kept in all the evaluation dates under 15%, reaching on evaluations 2, 3, 5, 7 and 8 values lower than 2%, while, in PSC the PD percentage fluctuated from 42 (evaluation 1) to 5% (evaluation 2), with a tendency of higher registers at 15% (dates 1, 4, 5, 6, 7, 8, 9, 10, 11 and 12). Likewise, it can be observed that even though the differential of PD among PSC and PCC oscillated from 27% (evaluation 1) to 4%

(evaluation 2) on PSC as on PCC these had the same tendency of presenting increments or reductions in evaluations 1, 2, 3, 4, 5, 5, 11, 12, which might be due to the same dynamic of ants populations. The results of the variance analysis allowed proving that damages caused by *A. sexdens* defoliating cassava plants, affect severely the yield (kg.ha^{-1}), generating a lost of 55% in PSC compare to PCC, which is confirmed by the correlation coefficient obtained evaluating the yield and number of damaged plants variables (-0.93). It must be say that the experimental error was considered an appropriate denominator for F state, since the sub-sampling effect was not seen.

On the other hand, the correlation coefficient between yield and the number of damaged plants (-0.93) and the regression analysis (yield = 25.04 – 1.06 PD), suggest the existence of a lineal and inverse relation among these variables, highlighting that the model explains a huge proportion of the total variance (r^2= 86.12%). Also, it can be indicated that the reduction on the number of plants to be cropped (45%) and the longitude of roots (34%) were the factors of higher influence on the observed reduction of the yield (table 1).

It can be considered that in spite of the number of roots/plants and the roots/plant weight were not statistically different (table 1) PSC presented higher values, this can be explained since in PSC, the density of plants was lower, therefore, the competence between plants reduced observing on these an increment on their productive values, reflected on the accumulation increment of the biomass or dry matter in roots. Another possible explanation might be related to the defoliations effect of *A. sexdens* on *Manihot esculenta* in PSC, which produces a significant lost in the longitude of roots, reducing the number of plants and the yield of roots in kg.ha^{-1}.

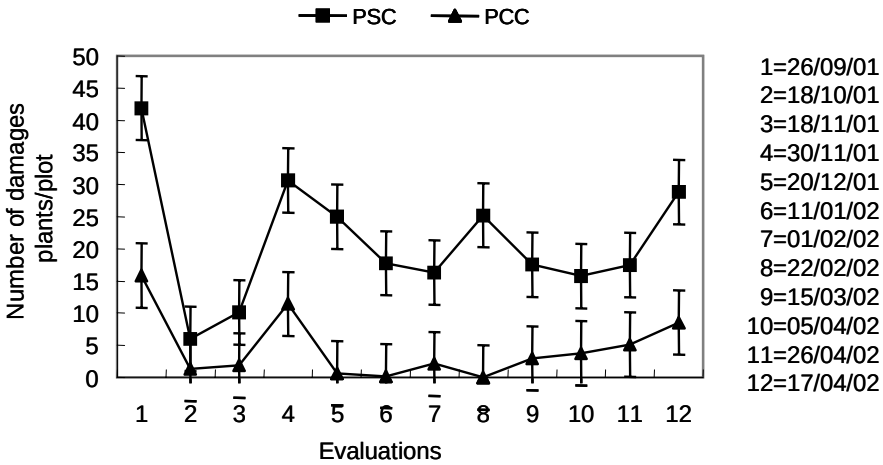

Figure 1. Damage caused by Atta sexdens in cassava during 2001-2002.

Table 1. Means obtained for variables number and weight of roots per plant, longitude, diameter and yield of roots.

Parameter	Variable					
	Plants (Plants.ha$^{-1)}$	Number of roots.plants^{-1}	Weight of roots. Plant^{-1} (kg.plant^{-1})	Average longitude of roots (cm)	Average diameter of roots (cm)	Yield of roots (kg.ha^{-1})
General mean	7.750*	3.51 ns	1.48 ns	28.35**	4.60 ns	12.495 **
Mean in PCC	10.000[a]	3.00	1.43	34.14 [a]	4.65	17.278[a]
Mean in PSC	5.500[b]	4.03	1.52	22.54[b]	4.55	7.712[b]

Note: PSC= plots where control was not done; PCC= plots where the pest was found; * and ** indicate significant differences among treatments for P<0.05 and P<0.01 respectively.

Likewise, it is important to mention that the yield is a direct function of the plants' density and the roots/plant weight, and for the latter, the diameter, longitude and the number of roots/plant constitute their direct components of the roots/plant weight and even though significant differences were observed in the longitude of roots, the differential among PCC and PSC (34%) was not enough to achieve the weight significance of roots/plant in function of the positive differential, which for PSC had the roots/plant number (25%), which generated a compensation effect.

Table 1 shows the averaged values obtained for the 6 analyzed variables, observing that the average diameter, number and weight of roots/plant were not affected by the treatment, while the number of plants, the average longitude of roots.plant^{-1} and the yield of roots (kg.ha^{-1}) are severe affected by the treatment. From these results, it is highlighted a reduction of 55% in yield of kg.ha^{-1} of PSC in relation to PCC.

Conclusions

A. sexdens and *A. landolti* were the leaf-cutter ants' species detected on the area under study, however, only the first may be considered as a pest for the cassava crop. On the other hand, a lineal and inverse relation was observed between the PD number and the components yields of this last variable. Differences in the weight of roots/plant were not observed in spite of the positive differential that for PCC had an average longitude of root (34%), by a compensation effect positive to the number of roots/plant (25%) in PSC. Therefore, the number of plants was the variable of higher weight in the differential observed of yield, which is 55%.

Acknowledgment

The authors thank the assistant technician José Luna Coll, by his collaboration in the collection of information, also they thank INIA-Anzoátegui and Fundacite by their financing provided for this research.

Literature cited

1. Bellotti, A. and A. Van Schoonhover. 1978. Cassava pest and their control. CIAT, Cali. Colombia. Series 09EC-2. 71 p.

2. Belloti, A., J. Reyes, O. Vargas, B. Arias and J. Guerrero. 1983. Descripción de las plagas que atacan la yuca (*Manihot esculenta* Crantz) y características de sus daños. CIAT Cali, Colombia. Serie 04SC-04.02. 51p.

3. Cedeño, A. 1984. La ecología de los bachacos. Fondo Editorial Acta Científica Venezolana. 73 p.

4. Cherret, J. and D. Peregrine. 1976. A review of the status of leaf-cutting ant and their control. Ann. of App. Biol., 84:124-128.

5. Farji, A. and J. Silva. 1995. Leaf cutting ants and forest groves in a tropical

parkland savanna of Venezuela:facilitated succession? J. of Trop. Ecol. 11:651-669

6. Hernández, J. and K. Jaffe. 1995. Dano economico causado por populacoes de formigas *Atta laevigata* en plantacoes de *Pinus caribaea*. Mor elementos para o manejo da praga. Anais da Sociedade Entomologica do Brasil, 24:(2) 287-298.

7. Hernández, J., C. Ramos, M. Borjas and K. Jaffe. 1999. Growth of *Atta laevigata* (Hymenoptera: Formicidae) nest in pine plantations. Florida Entomologist. 82:(1) 97-103.

8. Labrador, J., I. Martínez and A. Mora. 1972. *Acromyrmex landolti* Forel, plaga del pasto guinea (*Panicum maximun*) en el Estado Zulia. Rev. Fac. Agron. Univ. Zulia 2 (2):27-37.

9. LaPointe, S., M. Serrano and I. Corrales. 1996. Resistance to leafcutter ants (Hymenoptera: Formicidae) and inhibition of their fungal simbiont by tropica forage grasses. J. Econ. Entomol. 89(3):757-765.

10. Machado, W., M. Ascanio, J. Flores and F. Chacin. 2000. Manual de Prácticas de Diseño de Experimentos. Facultad de Agronomía. UCV. Maracacay. Venezuela. 148 p.

11. Martin, M. 1970. The biochemical basis of the fungus-attine ant symbiosis. Science. 169: 16-20

12. Navarro, J. and K. Jaffe. 1985. On the adaptative value of nest features in the grass-cutting ant *Acromyrmex landolti*. Biotropica. 17(4):347-348.

13. Rubio, E. and A. Timaure. 1977. Características de los nidos de *Acromyrmex landolti* (Forel) en el oeste de Venezuela. Revista de la Facultad de Agronomía. 4:(1)53-62.

14. Rubio, E., P. Leon, A. Tinaure and A. Mora. 1975. Resultados sobre el control de *Acromyrmex landolti* (Forel) plaga del pasto guinea (*Panicum maximun* Jacq.) en el Estado Zulia, Venezuela. Rev. Fac. Agron. Univ. Zulia 4(1):53-62.

15. Salzemann, A. and K. Jaffe. 1990. On the territorial behavior of field colonies of leaf-cutting ant *Atta laevigata* (Hymenoptera: Myrmicinae) J. Insect. Physiol. 36:(2) 133-138.

16. Steel, R. andJ. Torrie. 1960. Principles and procedures of statistics. Mc Grow Hill. Broth. Co. Inc. New York. USA. 622 p.

17. Vilela, E., K. Jaffe and P. Howse. 1987. Orientation in leaf cutting ant (Formicidae: Attini) Anim. Behav. 35: 143-153.

18. Whitehouse, M. and K. Jaffe. 1995. Nest mate recognition in the leaf-cutting ant *Atta laevigata*. Insect. Soc. 42:(2) 157-166