

Inventory of Loranthaceae parasites of Bayangam fruit trees in West Cameroon

Gilles Jiope Azangue^{1,2}  | Bonaventure Sonke¹ | Wauffo Fokom David³

¹Laboratory of Systematic Botany and Ecology, Higher Teachers' Training College, University of Yaounde I, Yaounde, Cameroon

²Applied Botany Research Unit, University of Dschang, Dschang, Cameroon

³Department of Biological Sciences, Institute of Agricultural Research for Development, Bangangte, Cameroon

Correspondence

Gilles Jiope Azangue, Laboratory of Systematic Botany and Ecology, Higher Teachers' Training College, University of Yaounde I, Yaounde, Cameroon.

Email: azangilles@yahoo.fr

Abstract

Background: Loranthaceae parasitism is a limiting factor for crops as well as many other plant diseases and pests. The present study was conducted to make an inventory of Loranthaceae present on fruit trees species grown in the Bayangam locality. It also aimed to record the damage caused by these pests on the host plants. To achieve this, 40 transects of 100 m length and 50 m width were set up in the locality of Bayangam. Observations were made on the presence or absence of the parasites on the host plants, the number of Loranthaceae clumps carried by each parasitized tree, the taxon of the parasite, and the damage caused by the Loranthaceae on the host plants.

Results: The inventories identified six species of Loranthaceae belonging to four genera. These were *Globimetula braunii*, *Globimetula dinklagei*, *Globimetula oreophila*, *Helixanthera mannii*, *Phragmanthera capitata*, and *Tapinanthus globiferus*. Parasite densities varied among species and increased with the circumference of host plants. *Globimetula braunii* and *Phragmanthera capitata* were the most invasive species on host plants.

Conclusion: Fruit trees in Bayangam are largely parasitized by Loranthaceae. The only control method used by the populations is pruning of parasitized branches during drought periods. This method is not effective because of the large number of trees and branches parasitized. The identification of Loranthaceae-resistant cultivars in fruit tree production is an interesting element in the perspective of control.

KEYWORDS

Bayangam, botanical inventories, fruit trees, Loranthaceae, parasitism

INTRODUCTION

Loranthaceae are hemiparasitic epiphytoid phanerogams capable of photosynthesis by drawing water and mineral salts from a host plant.¹ These parasitic phanerogams, which are characterized by a nutrition carried out at the expense of their hosts,² are responsible for variable economic damages according to the parasitized crops or woody species.³ These hemiparasites on woody plants slow down the growth of the host, causing an alteration in the quality of the wood and making it more susceptible to other pathogens.⁴ Loranthaceae grow rapidly and have a great ability to attach themselves in many places on the

host. The host can be completely invaded, which rapidly causes a generalized weakening of the host characterized by permanent defoliation, massive drying of the affected branches, and scarce flowering and fruiting.⁴ The host plant may then die or lose its economic value.⁵ Several studies have shown that many plant species of economic importance or maintained by man are infested by Loranthaceae in Africa. Examples include leguminous plants in Côte d'Ivoire,⁶ rubber trees,⁷ and avocado trees in Cameroon.¹

In Cameroon, parasitism of woody species by Loranthaceae is a scourge for crops in the same way as many diseases and other plant pests that have been studied more extensively.¹

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These parasitic species are a real constraint for orchards and spontaneous species.⁸ Thus, Loranthaceae are present in many orchards and home gardens and are a permanent threat to their hosts.¹

The highlands of western Cameroon supply a large part of the country with fruits and vegetables. In Bayangam and many other localities in the West Cameroon region, trees in many ecosystems and home gardens are invaded by Loranthaceae. In this region, the damage caused by Loranthaceae on fruit trees is enormous. Unfortunately, farmers do not always have the appropriate means to fight against the scourge of these parasitic plants.¹

A review of the literature revealed that few studies have been devoted to this scourge in this part of Cameroon.^{1,9} Yet it is a scourge that has serious negative consequences for farmers' production and yields. In view of the severe attacks caused by Loranthaceae on crops and their abundance in the locality of Bayangam, we undertook to study the parasitism of fruit trees by Loranthaceae in this locality. The objective of this work is therefore to make a botanical inventory of the different types of Loranthaceae that parasitize fruit trees in Bayangam and to describe the types of damage caused by these parasites on the host plants.

MATERIALS AND METHODS

The work was carried out in the Bayangam locality. Bayangam (latitude 5°13'43.24" N, longitude 10°27'56.59" E) is located in the West Cameroon region, in the Koung-Khi department. The village covers an area of 91 km². The Commune of Bayangam has a fairly rugged and varied relief, with plains and valleys in places. The plains are more fertile and favorable to several crop varieties. The Commune of Bayangam is subject to a Guinean-type equatorial climate, with four seasons of unequal duration:

- A long dry season from November to mid-March.
- A short rainy season from mid-March to mid-June.
- A short dry season from mid-June to mid-August.
- A long rainy season from mid-August to the end of October.¹⁰

Average annual rainfall is 1,577 mm. The average annual temperature is 25°C. This climate is conducive to two agricultural seasons a year. The soil parent material is essentially granite. Three main soil types are found in this locality: ferralitic soils, silty soils, and volcanic soils. Bayangam's vegetation is essentially dense secondary forest. The main exploitable species are Eucalyptus, and certain non-wood products used in handicrafts (rattan, raffia and its derivatives, Chinese bamboo, and certain lianas). The rest of the vegetation around the houses is made up of plantations and food crops, fallow land, and fruit trees. Wildlife includes wild animals, especially small rodents.¹⁰

In the Bayangam locality, we selected sites within the plantations based on their high density of trees and shrubs likely to harbor Loranthaceae species. A total of 40 transects of 100 m length and 50 m width were set up. Along each transect, all woody species were surveyed. For each tree inventoried, the following parameters were recorded:

- The name of the host species.

- The presence or absence of Loranthaceae on the host plant.
- The measurement of the trunk circumference at 1.30 m from the ground, to establish a relationship between parasitism by Loranthaceae and the age of the tree.
- An inventory of the species of Loranthaceae present.
- Counting the number of Loranthaceae clumps carried by each tree.
- The herbarium of each Loranthaceae species encountered and the host species for their identification or subsequent confirmation at the National Herbarium of Cameroon.

The following parameters were then evaluated:

- The Loranthaceae species richness in the region.
- The average parasite density, which is the number of parasites (or haustoria) divided by the total number of parasitized plants for each host species (ADP).
- The percentage of parasitized plants for each host species.
- The average number of Loranthaceae clumps per circumference class for each host species.

The grouping of the data into circumference classes was done using a known classical rule¹ that determines a minimum number K of classes based on the number N of a set of trees studied:

$$K = 1 + (10 \log_{10} N) / 3.$$

The extent of the class is obtained by dividing the extent of the series by K-1, and the extent of the series is the difference between the largest and smallest circumference.

RESULTS AND DISCUSSION

Results

Checklist of Loranthaceae in the Bayangam agrosystems

The inventory identified six species of Loranthaceae in the Bayangam agrosystems. These were *Globimetula braunii* (Engler) Van Tieghem, *Globimetula dinklagei* (Engler) Van Tieghem, *Globimetula oreophila* (Oliver) Van Tieghem, *H. mannii* (Oliver) Danser, *Phragmanthera capitata* (Sprengel) S. Balle, and *Tapinanthus globiferus* (A. Richard) Van Tieghem. Their presence and abundance varied with the tree species present in the agrosystem and also with the age of the parasitized plants.

Host species and Loranthaceae species present in the Bayangam agrosystem

Following our inventories, the host plants present in the agrosystems were mostly fruit trees. These were *Persea americana* Mill.

TABLE 1 List of fruit host species surveyed and their parasites.

Loranthaceae species	G.	G.	G.	H.	P.	T.	Parasite	Average parasite
Host plants	<i>braunii</i>	<i>dinklagei</i>	<i>oreophila</i>	<i>mannii</i>	<i>capitata</i>	<i>globiferus</i>	density (PD)	density (APD)
<i>Canarium Schweinfurthii</i> (57/53)	1024	-	-	-	-	-	1024	19.32
<i>Cola anomala</i> (288/132)	-	45	02	42	401	27	517	3.91
<i>Dacryodes edulis</i> (191/120)	1178	-	-	-	09	-	1187	9.97
<i>Persea americana</i> (316/212)	-	40	63	12	1922	15	2052	9.5
<i>Psidium guajava</i> (56/29)	-	19	02	01	99	4	125	3.78
Total	2202	104	67	55	2431	46	4905	46.48

Note: For each host plant, the first number (inside the parenthesis) indicates the number of individuals surveyed and the second, the number of individuals parasitized. For each Loranthaceae, the numbers inside the columns represent the number of parasite clumps for that species.

(Lauraceae), *Cola anomala* K. Schum (Malvaceae), *Dacryodes edulis* (G. Don) H. J. Lam. (Burseraceae), *Canarium schweinfurthii* Engl (Burseraceae), *Psidium guajava* Linn. (Myrtaceae), and *Mangifera indica* L. (Anacardiaceae). Other parasitized host plants were not fruit trees but are used in the construction of living hedges. These include *Markhamia lutea* (Benth.) K. Schum (Bignoniaceae) and *Stereospermum acuminatissimum* K. Schum (Bignoniaceae). Other host plants present in the locality are used for the making of the frameworks of the houses and we can quote in this case *Afrocarpus mannii* Hooker F. (Podocarpaceae) and *Eucalyptus* sp. (Myrtaceae). Other species are used as firewood, such as *Polyscia fulva* (Hiern) Harms (Araliaceae) or as ornamental plants, such as *Terminalia mantaly* H. Perrier (Combretaceae). Table 1 lists the fruit plants that were the most parasitized host species and the Loranthaceae that parasitize each host species.

From Table 1, it can be seen that the parasite densities obtained in host plants vary from species to species. The most parasitized host plants in decreasing order are *C. schweinfurthii*, *D. edulis*, *P. americana*, *C. anomala*, and *P. guajava*. The average parasite densities are highest in *C. schweinfurthii* (APD = 19.32) and *D. edulis* (APD = 9.97). *G. braunii* is the Loranthaceae found only on these two host species. Parasite density is also high in *P. americana* (ADP = 9.5), which is largely parasitized by *P. capitata*. The other Loranthaceae species, *G. dinklagei*, *G. oreophila*, *H. mannii*, and *T. globiferus*, are also present in many host species but with lesser numbers of clumps compared to

P. capitata. It is noted, however, that although having low clump numbers, these species sometimes form very large clumps that almost completely invade the foliage of the host. *P. capitata* is the most frequent species on the host species and constitutes with *G. braunii* the most invasive species. They are the most problematic species in plantations.

Distribution of Loranthaceae clump numbers according to host plant circumference classes

The distribution of the average number of Loranthaceae clumps according to circumference classes was done on five species of fruit trees because they are the most cultivated fruit trees in the agrosystem. These are *C. schweinfurthii*, *C. anomala*, *P. americana*, *D. edulis*, and *P. guajava*.

Distribution of the average number of Loranthaceae clumps according to circumference classes in *P. americana* (Lauraceae)

The distribution of the average number of Loranthaceae clumps according to circumference classes in *P. americana* is presented in Table 2.

Table 2 shows that the average number of Loranthaceae clumps increases with tree circumference. The average number of clumps increases from 1.28 for circumferences between 0 and 30 cm to 48 clumps for circumferences greater than 241 cm. On

TABLE 2 Distribution of the average number of clumps of Loranthaceae according to circumference classes in *Persea americana*.

Parasitic trees	Circumference classes (in cm)									Total	RTP (%)
	0-30	31-60	61-90	91-120	121-150	151-180	181-210	211-240	241-270	-	-
No	21	46	21	6	2	0	0	0	0	96	-
Yes	7	51	74	47	28	3	3	1	2	216	69.23
Total	28	97	95	53	30	3	3	1	2	312	-
Average number of clumps	1.28	4.60	7.39	11.72	17.28	18	26.33	27	48	-	-

Abbreviation: RTP, rate of parasitized trees.

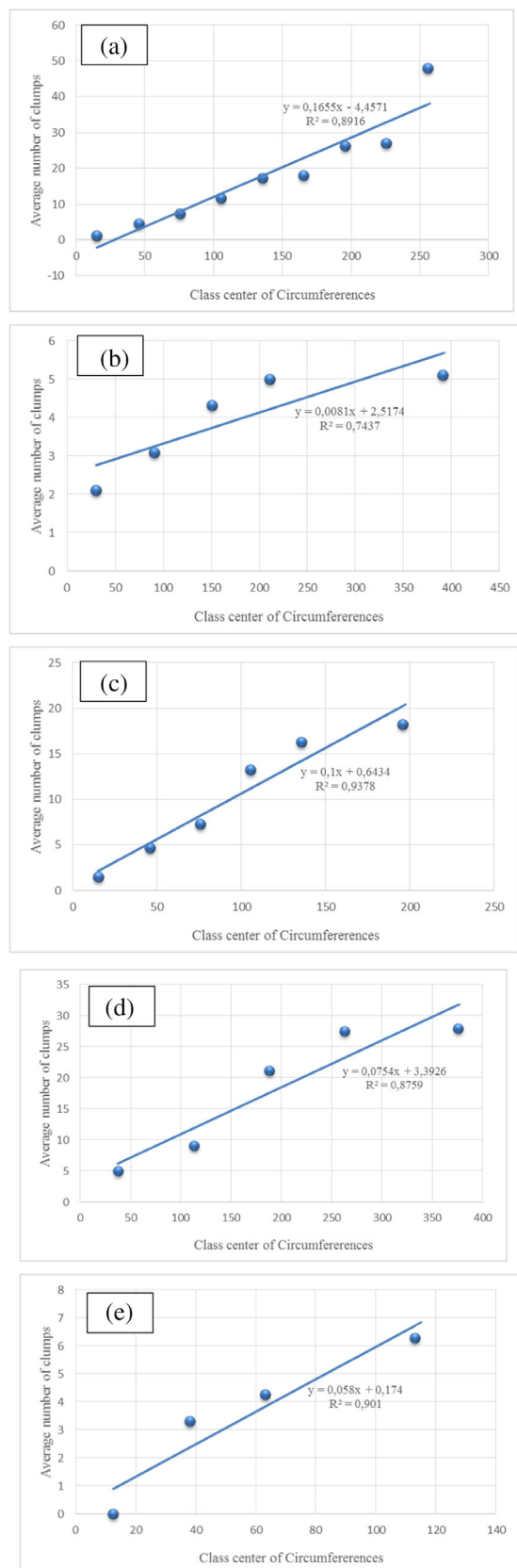


FIGURE 1 Regression line between the average number of Lanthaceae clumps and the average trunk circumference. (a) *Persea americana*, (b) *Cola anomala*, (c) *Dacryodes edulis*, (d) *Canarium schweinfurthii*, and (e) *Psidium guajava*.

P. americana, up to 49 clumps were observed on an individual with a circumference of 259 cm.

A measure of the correlation (Figure 1a) obtained by calculating the linear correlation coefficient (R) between the average number of Lanthaceae tufts and the circumference of the trees in *P. americana* shows a strong correlation between the two variables ($R = 0.94$).

Distribution of the average number of Lanthaceae clumps according to circumference classes in *C. anomala* (Malvaceae)

The distribution of the mean number of Lanthaceae clumps in *C. anomala* is shown in Table 3. The last five classes (241–540 cm) were merged due to the low number of host plants within these classes.

The average number of Lanthaceae clumps obtained from *C. anomala* (Table 3) increased with tree circumference. The average number of clumps is low and equal to 2.11 in host plants of the first class (circumference less than 60 cm). The number of clumps of Lanthaceae increases progressively until reaching an average of 5.11 clumps for circumferences greater than or equal to 241 cm. In *C. anomala*, a maximum of 34 clumps were obtained in an individual with a circumference equal to 500 cm.

In *C. anomala*, the linear correlation coefficient obtained ($R = 0.86$) shows that there is a strong dependence between the average number of Lanthaceae tufts and the circumference of the trees (Figure 1b).

Distribution of the average number of Lanthaceae clumps according to circumference classes in *D. edulis* (Burseraceae)

In *D. edulis*, the last three circumference classes (151–240 cm) were merged because of the low number of plants within these classes. Data obtained from the inventory of *D. edulis* plants (Table 4) show that the average number of clumps increases with the circumference of the individuals surveyed.

The average number of clumps is low for individuals in the first class (less than 30 cm) where there is about one clump and increases to more than 18 clumps for circumferences greater than 151 cm.

Examination of the correlation between the average number of Lanthaceae clumps and tree circumference in *D. edulis* (Figure 1c) shows that there is a strong correlation between these two variables ($R = 0.96$).

Distribution of the average number of Lanthaceae clumps according to circumference classes in *C. schweinfurthii* (Burseraceae)

The data obtained during the inventory in *C. schweinfurthii* (Table 5) show that the average number of clumps is low for individuals in the first class where there are only five clumps.

The average number of clumps of Lanthaceae increases progressively with circumference, reaching 27 clumps for circumferences greater than or equal to 226 cm. In *C. schweinfurthii*, the last two classes (from 301 to 450 cm) were merged because of the low number of host plants within these classes.

TABLE 3 Distribution of the average number of Loranthaceae clumps according to circumference classes in *Cola anomala*.

Parasitic trees	Circumference classes (cm)					Total	RTP (%)
	0–60	61–120	121–180	181–240	241–540	-	-
No	27	68	30	19	12	156	-
Yes	9	43	40	23	17	132	45,83
Total	36	111	70	42	29	288	-
Average number of clumps	2,11	3,09	4,32	5	5,11	-	-

Abbreviation: RPT: rate of parasitized trees.

TABLE 4 Distribution of the average number of Loranthaceae clumps according to circumference classes in *Dacryodes edulis*.

Parasitic trees	Circumference classes (cm)						Total	RTP
	0–30	31–60	61–90	91–120	121–150	151–240	-	-
No	17	25	22	5	1	1	71	-
Yes	2	21	44	29	19	5	120	62.82
Total	19	46	66	34	20	6	191	-
Average number of clumps	1.50	4.66	7.27	13.24	16.26	18.20	-	-

Abbreviation: RPT, rate of parasitized trees.

TABLE 5 Distribution of the average number of Loranthaceae clumps according to circumference classes in *Canarium schweinfurthii*.

Parasitic trees	Circumference classes					Total	RTP
	0–75	76–150	151–225	226–300	301–450	-	-
No	1	0	2	0	1	4	-
Yes	3	12	20	10	8	53	92.98
Total	4	12	22	10	9	57	-
Average number of clumps	5	9.08	21.15	27.50	27.87	-	-

Abbreviation: RPT, rate of parasitized trees.

TABLE 6 Distribution of the average number of Loranthaceae clumps according to circumference classes in *Psidium guajava*.

Parasitic trees	Circumference classes				Total	RTP
	0–25	26–50	51–75	76–150	-	-
No	4	14	5	4	27	-
Yes	0	10	12	7	29	51.78
Total	4	24	17	11	56	-
Average number of clumps	0	3.30	4.25	6.28	-	-

Abbreviation: RPT, rate of parasitized trees.

The study of the correlation (Figure 1d) between the average number of tufts of Loranthaceae and the circumference of the trees in *C. schweinfurthii* shows that the two variables are strongly correlated ($R = 0.93$).

Distribution of the average number of Loranthaceae clumps according to circumference classes in *P. guajava* (Myrtaceae)

The data obtained on the distribution of the average number of clumps of Loranthaceae according to circumference classes in

P. guajava show that the individuals of the first class, that is, from 0 to 25 cm, are not parasitized (Table 6). The average number of tufts then increases with circumference until reaching more than six tufts for circumferences greater than 76 cm. In *P. guajava*, the last three classes (from 76 to 150 cm) were merged because of the low number of trees within these classes.

A linear correlation coefficient study (Figure 1e) shows that the average number of Loranthaceae clumps is 94% dependent on tree circumference in *P. guajava*.

DISCUSSION

Among the 26 species of Loranthaceae reported in Cameroon,¹¹ 6 were inventoried in Bayangam. These are *G. braunii*, *G. dinklagei*, *G. oreophila*, *H. mannii*, *P. capitata*, and *T. globiferus*. Among the species inventoried, *P. capitata* and *T. globiferus* had already been reported by Sonké et al.¹ as the main species parasitizing *P. americana* in the Yaoundé region along with *Tapinanthus ogowensis*. Similarly, *G. dinklagei*, *G. braunii*, and *P. capitata* were reported among the Loranthaceae found in the Bafou group in western Cameroon by Jiofack et al.¹²

A study of the distribution of the average number of Loranthaceae clumps according to circumference classes on *C. schweinfurthii*, *P. americana*, and *D. edulis*, shows that individuals in class 1, corresponding to the youngest trees, are poorly or not at all parasitized, while individuals in intermediate and larger classes are heavily parasitized. This is because the young trees do not yet produce the flowers and fruit likely to attract Loranthaceae seed-disseminating birds. In *C. anomala* and *P. guajava*, the average number of tufts is not very high in the individuals of the highest classes where there are 5.11 and 6.28 tufts, respectively. From one circumference to the other, the rate of parasitism increases in the same direction as the class boundaries. This is explained by the fact that trees in the high circumference classes have undergone multiple infestations by Loranthaceae seeds during their multiple flowering and fruiting periods and those of the Loranthaceae. The results obtained on the Bayangam host species are comparable to those obtained by Sonké et al.¹ on *P. americana* in the Yaoundé region, where the number of Loranthaceae clumps increased with tree circumference.

Field observations showed that the size of Loranthaceae clumps on a host plant is independent of the number of clumps and that sometimes a single clump can invade a large part of the host foliage. Maximums of 48 clumps were observed on individuals of *P. americana*, *C. schweinfurthii*, and *D. edulis*. Beyond 20 clumps, the foliage of the parasites represents more than half of that of the host, which causes the invasion of the parasitized individual, then a more or less important deficit of nutritive elements whose consequences are the stop of growth, the decline and the death of the host as described by Boussim et al.⁴ and Sonké et al.¹

P. capitata was the most widespread Loranthaceae on the host plants. These results confirm the observations made on *P. capitata* by Balle⁷ on the study of Loranthaceae in Cameroon, by Guyot and Ntawanga¹² on rubber trees, by Sonké et al.¹ on *P. americana* in Yaoundé, by Djuikouo¹³ in the cocoa plantations of Mfou and Mbankomo, and by Dibong et al.¹⁴ on fruit trees in Douala. Observations that *P. capitata* is a ubiquitous species, which adapts to several ecological variations and parasitizes a wide range of host plants.

It should be noted that despite the high infestation rate of trees in plantations, *M. indica* (Anacardiaceae) and *P. fulva* (Araliaceae) remain entirely free of parasites. This was previously reported by Boussim et al.⁴ on *M. indica* where they assumed that the tissues of this plant would not allow parasite attachment.

A simple regression study between the average number of Loranthaceae clumps on parasitized trees and the trunk circumference of the trees showed that these two variables were highly correlated in all species studied.

The expansion of Loranthaceae in Bayangam is caused by the abundance of woody plants on which they develop easily and also by birds which are the vectors for the dissemination of seeds from one host plant or branch to another as described by Boussim et al.⁴ Also by their polyphytic character as reported by Jiofack et al.¹⁵ and Amon et al.⁸ The lack of effective control methods against these pests and the multiple flowering and fruiting periods of Loranthaceae also favor their expansion as reported by Boussim et al.⁴ and increase the possibilities of Loranthaceae seed dissemination.

CONCLUSION

The studies conducted on the parasitism of Loranthaceae in Bayangam allowed the inventory of six species: *G. braunii*, *G. dinklagei*, *G. oreophila*, *H. mannii*, *P. capitata*, and *T. globiferus*. Of all the Loranthaceae species found in Bayangam, *P. capitata*, and *G. braunii* are the most invasive and damaging to host species. The statistical study was conducted on five species of fruit trees, represented by 904 individuals. The overall percentage of parasitism was 64.53% for all these five host species. In the absence of effective control methods, this rate could increase. The study of parasite densities between the different host species revealed that parasite densities vary from one species to another. They are highest in *C. schweinfurthii*, *D. edulis*, and *P. americana*; however, *M. indica* and *P. fulva* do not carry parasites. *G. braunii* specifically parasitizes two host species (*C. schweinfurthii* and *D. edulis*), which belong to the family Burseraceae. Distribution of parasites by circumference classes showed that the number of Loranthaceae clumps on host species increased with host plant circumference. This is because young plants are not attractive to disseminating birds. The most apparent damage observed was host invasion, bulging of the parasite attachment point, and drying of the host plant during drought. The control method most used by the populations is pruning of parasitized branches at the end of the drought period (February and March) but this control method is not very effective because of the large number of parasitized trees and branches.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest in relation to this article.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ORCID

Gilles Jiope Azangue  <https://orcid.org/0000-0002-8335-4933>

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