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# Alternative Host Plants of *Clavigralla tomentosicollis* Stäl (Hemiptera:Coreidae), the Pod Sucking Bug of Cowpea in the Sahelian Zone of Burkina Faso

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**Abstract:** Refuge plants, by offering egg laying and feeding substratum to bugs could be potential reservoirs from where adult bugs responsible of primary infestation in cowpea fields would spread in rainy season. Studies were carried out in the three phytogeographic zones of Burkina Faso to identify host plants of *Clavigralla tomenstosicollis* populations, the pest of cultivated cowpea, in dry season. Theses studies in the residual herbaceous, shrubby and arboreal vegetation enabled the identification of 24 herbaceous plants hosting at least one of the development stages (eggs, larvae, adults) of the bug in dry season. These plants are divided into eleven families, the Fabaceae family being the most important. However, six legume species, *Cajanus cajan* (L.), *crotalatia retusa* (L.), *crotalaria* sp., *Rhynchosia memnonia* (Del.), *R. minima* and *R. orthobothrya* seem to be the most frequent alternative hosts. Throughout the dry season, bug eggs and/or larvae or adults were observed, indicating a likely continuous insect reproduction in the absence of cowpea. This study discusses the importance of knowing the plants on which bug residual populations spend dry season for the appropriate development of an integrated control method.

**Key words:** Cowpea, *Clavigralla tomentosicollis*, dry season, alternative host plant, integrated control

## INTRODUCTION

Among the bugs that cause damages to cowpea pods, *Clavigralla tomentosicollis* Stäl. (Hemiptera: Coreidae; synonym: *Acanthomia tomentosicollis* Stäl.) is the most spread and devastating species in Burkina Faso[1,2]. Larvae and adult bugs sucking maturing pods may cause a yield loss may cause an important yield loss[3-5]. The reduction of grain germinating capacity is also an indirect consequence of the bug action[6].

How does this insect survive during dry season in the Sahelian semi-arid tropical zone characterized by low humidity and high temperatures? Insects have physiological, nutritional, physical and biological needs that they secure from the environment for their survival. During their evolution, they are compelled to live in ecological niches that fulfil these needs essential to their reproduction to perpetuate the species. The seasonal cycle has optimal as well as unfavourable periods that insect populations go through with more or less fortune. They can migrate with the wind towards more favourable areas (change of habitat), in search of their host or other alternative plants in the absence of the usual host that they will invade during the favourable period.

Since, more or less important infestations of *C. tomentosicollis* pod sucking bugs occur every year, it is certain that the pest subsists during the bad season. At the end of the cropping season, the population density drops when cowpea pods are harvested. Adult bugs migrate[2]. Then we have two assumptions: (I) they keep developing by changing hosts or (ii) they suspend their development cycle through diapause[7].

To elucidate the question, we undertook two types of studies:

- The evolution of *C. tomentosicollis* populations throughout the year, with the continuous cropping of two host crops, *V. unguiculata* cowpea and *Cajanus cajan* pigeon pea in Kamboinsé.
- The search for alternative host plants and the importance of residual populations in dry season.

The specific objectives is to study the biological cycle through a year, *C. tomentosicollis* host plants are

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to know the insect biological cycle and to identify plants other than cowpea on which residual populations live in natural conditions during dry season. In West Africa, this prospecting study has not been carried out in semi arid tropical zone, except in Nigeria.

## MATERIALS AND METHODS

**Evolution of *C. tomentosicollis* populations on *V. unguiculata* and *C. cajan* throughout the year:** Crops were established and maintained throughout the year by ensuring additional irrigation during dry season from June 1997 to June 1999.

**The cowpea crop:** Plots of 5x10 m were prepared for scheduled seeding of the cowpea sensitive cultivar, KN1. Seed spacing was 80 cm between lines and 40 between pockests. A fifteen-day interval was observed between two consecutive planting dates. Thus we could have pods of all phenological stages all around the year.

**The *Cajanus cajan* (M.) crop:** As a pluri-annual variety, the crop was established in two alternate rows. Spaces between lines are 80 cm and spaces between pockest are 50 cm. It is an evergreen plant, with a non-stop flowering and production of pods as long as it is watered. Relative temperature and humidity were measured, using a thermo-hygrograph placed to this effect.

**Sampling method:** Observations were made once a month, between 8:00 and 10:00 am from November 1997 to June 1999.

On cowpea, we sampled and counted adults (by sex), larvae (by stage), eggs of *C. tomentosicollis* and its natural enemies using a metallic cage covered with a 1x1m base mosquito net tissue randomly placed in the plot. The cage is placed 20 times at each observation. On *C. cajan* the sampling method was based on a visual observation, on ten plants randomly selected and individually monitored. The same variables were studied, as for cowpea.

**The search for alternative host plants:** The search for *C. tomentosicollis* host plants included exploratory searches conducted between 1997 and 1999, in dry season, either by scouring cowpea plots and their surroundings after harvest, or by systematically searching in the bush surrounding water spots or in lowlands. These studies were carried out in 12 sites covering the 3 phytogeographic zones. The main characteristics of these zones have been described[8]:

- The low rainfall sub-Sahelian zone (400-600 mm/year) characterized by savannah vegetation with thorny trees had two sites.
- The average rainfall northern Sudanian zone (600-800 mm/year) dominated by scattered tree and bush savannah vegetation. Observations were done in 5 sites.
- The higher rainfall southern Sudanian zone (800-1200 mm/year) where the flora is more dense and varied with tree and bush savannah and sparse forest. We did the sampling in 6 sites.

In all the study zones, dry season is generally characterized by a reduction of vegetation cover, high temperatures (maximal ranging between 35 and 45°C), dry atmosphere (air relative humidity below 30%) and dry harmattan winds.
In each site, we carried out:

- Visual observations on herbaceous plants to search for adult insects, larvae or bug eggs.
- On shrubs, we applied the Ratnadass method[9] to collect sorghum head bugs on indigenous host plants in Mali. We shook the entire plant (or part of it), covered with a transparent polyethylene bag (80x60 cm) and this enables to collect the insects (larvae and adults) that are taken to laboratory for identification and count.
- On the trees, a tarpaulin was placed under and branches were sprayed with a knock down effect insecticide (a mixture of Deltamethrin and Dimethoate). By shaking the treated branches, dead or knocked down insects fall. They are then put in alcohol at 70%, counted and identified.

Whatever the sampling method, *C. tomentosicollis* eggs were counted directly on the plants. Samples were taken and incubated in laboratory. After hatching, larvae were fed with cowpea pods until adult stage to confirm species identification. Host plants identified by the Botanic section of CNRST Forest Production Department were used to enrich the laboratory herbarium.

**Development of *C. tomentosicollis* larvae on *Rhynchosia minima* pods and *Hibiscus esculentus* okro fruits:** Almost throughout the year, we harvested all the bug development stages on *Rhynchosia minima* L. and those of the adults and eggs on the *Hibiscus esculentus* okro fruits. These plants species are supposed to be secondary hosts for the insect. Studies related to the duration of bug larval development on *R. minima* pods and okro fruits

were carried out in August 1998 in the laboratory prevalent environment using plastic petri dishes placed on drainboard. Average temperatures ranged between 26 and 30°C. The average relative humidity fluctuated between 58 and 74%.

Newborn larvae from eggs previously incubated in laboratory prevailing conditions were separated and placed one by one in numbered, covered Petri dishes containing pods or okro fruit. Eight to ten day old cowpea pods at filling stage were controls. The presence of an exuvia in the Petri dish would indicate the development from one stage to the other. In case of moult, the exuvia is taken out of the dish. The mean length of a larval stage is the mean of the development stage length for all the monitored larvae. We also evaluated the growth index (G. I.) indicating the suitability of feeding medium for the insect by the following formula[10]: G.I. = Survival rate/total larvae development length. There were two daily observations, at 7:00 am and 7:00 pm.

The daily larval survival is the number of surviving larvae from infestation day to the observation day. The survival rate is the rate of adults obtained from L1 larvae. The larval development length is the period between hatching and fledgling.

## RESULTS

**Evolution of *C. tomentosicollis* populations on *V. unguiculata* and *C. cajan* throughout the year:** Despite the continuous presence of pods at filling stage, the bug only infests significantly the cowpea crop, at rainy season, with only one peak in September (Fig. 1A). Females lay eggs between July and November (Fig. 2A). The bug populations decrease drastically from November and are totally absent between March and May. They infest again, through adults, from June, the following year.

On the opposite *C. cajan* continually hosts all the forms of bug development whatever the year (Fig. 1B and 2B). The highest number of insects pullulated from June to February. The lowest number was observed between March and May of each year.

**The search for alternative host plants:** Research carried out in natural conditions during the dry season helped to collect *C. tomentosicollis* throughout the year in the residual vegetation of each of the 3 research zones (Table 1 and Fig. 3). Nearly 65% of host plants were found in the northern Sudanian zone certainly because of its more important and varied flora. Results obtained show

Table 1: Plants species hosting different developmental stages of *C. tomentosicollis* in 3 phytogeographic zones of Burkina Faso Data recorded from 1997 to 1999

| | | Developmental stages of *C. tomentosicollis* | | | |
|---|---|---|---|---|---|
| Host plant species | Plant family | Eggs | Larvae | Adults | Total |
| *Acanthospermum hispidum* DC.[3] | Compositae | + | + | + | 9 |
| *Borreria radiata* DC.[3] | Rubiaceae | + | + | + | 6 |
| *Cajanus cajan* (L.) Millsp.[1,2,3] | Fabaceae | + | + | + | 64 |
| *Canavalia* sp.[3] | Fabaceae | + | + | + | 8 |
| *Celosia trygina* L.[3] | Amaranthaceae | + | + | - | 2 |
| *Commelina forskalaei* Vahl.[3] | Commelinaceae | + | + | + | 12 |
| *Crotalaria retusa*[1,2,3] | Fabaceae | + | + | + | 19 |
| *Crotalaria* sp.[2] | Fabaceae | + | + | + | 19 |
| *Croton lobatus*[3] | Euphorbiaceae | - | - | + | 3 |
| *Hibiscus esculentus* L.[2,3] | Malvaceae | + | - | + | 14 |
| *Hyptis spicigera* Lam.[3] | Lamiaceae | + | + | + | 16 |
| *Hyptis suaveolens* Poit[3] | Lamiaceae | + | - | + | 3 |
| *Indigofera nigritana* Hook[3] | Fabaceae | + | + | + | 10 |
| *Indigofera pulchra* Willd[3] | Fabaceae | + | + | + | 10 |
| *Leucas martinicensis* (Jacq.) Ait.[3] | Lamiaceae | + | + | + | 7 |
| *Nicotiana rustica* L.[2] | Solanaceae | - | - | + | 1 |
| *Pennisetum typhoïdes*[2] | Graminaceae | - | - | + | 6 |
| *Rhynchosia memnonia* (Del.) DC.[2] | Fabaceae | + | + | + | 28 |
| *Rhynchosia minima* (L.) DC.[2] | Fabaceae | + | + | + | 35 |
| *Rhynchosia orthobothrya* Harms.[3] | Fabaceae | + | + | + | 18 |
| *Sida linifolia* Juss.[3] | Malvaceae | - | - | + | 3 |
| *Sphenostylis holosericea* Welw.[3] | Fabaceae | - | - | + | 4 |
| *Tephrosia pedicellata* Bak.[3] | Fabaceae | + | + | + | 9 |
| *Tridax procumbens* L.[3] | Capparidaceae | + | + | + | 6 |

[1]Plant species found in the sub-Sahelian zone [2] Plant species found in the northern Sudanian zone [3] Plant species used found in the southern Sudanian zone
+ Presence of *C. tomentosicollis* - Absence of *C. tomentosicollis*

Table 2: Survival of *C. tomentosicollis* larvae reared on the pods of *V. unguiculata*, *R. minima* and on the okro fresh fruits (*H. esculentus*) in the laboratory prevalent environment

| | Development substratum | | |
|---|---|---|---|
| | *V. unguiculata* pods | *R. minima* pods | *H. esculentus* fresh fruits |
| Number of initial larvae used | 30 | 34 | 30 |
| Number of adults obtained | 29 | 29 | 0 |
| Rate of survival | 96.8 | 85.3 | 0.00 |
| Growth index | 9.18 | 7.90 | 0.00 |

Table 3: Development length of different larval instars of *C. tomentosicollis* reared on the pods of *V. unguiculata*, *R. minima* and on the fresh fruits of *H. esculentus* in the laboratory prevalent environment

| | *V. unguiculata* pods | | *R. minima* pods | | *H. esculentus* fresh fruits | |
|---|---|---|---|---|---|---|
| Larval instars | Number of larvae | Development length | Number of larvae | Development length | Number of larvae | Development length |
| 1 | 30 | 1.98±0.09a | 34 | 2.01±0.08a | 27 | 2.00±0.00a |
| 2 | 30 | 1.70±0.25a | 30 | 1.67±0.35a | 22 | 2.79±0.50b |
| 3 | 29 | 1.43±0.17a | 29 | 1.38±0.25a | 4 | 3.12±0.25b |
| 4 | 29 | 2.09±0.19a | 29 | 2.02±0.36a | - | - |
| 5 | 29 | 3.34±0.48a | 29 | 3.71±0.53b | - | - |
| Total development length | | 10.53±0.56a | | 10.79±0.37b | | - |

Means followed by the same alphabetic letter within a row are not significantly different according to the Student Newman Keuls multiple comparison test at the 5% level.

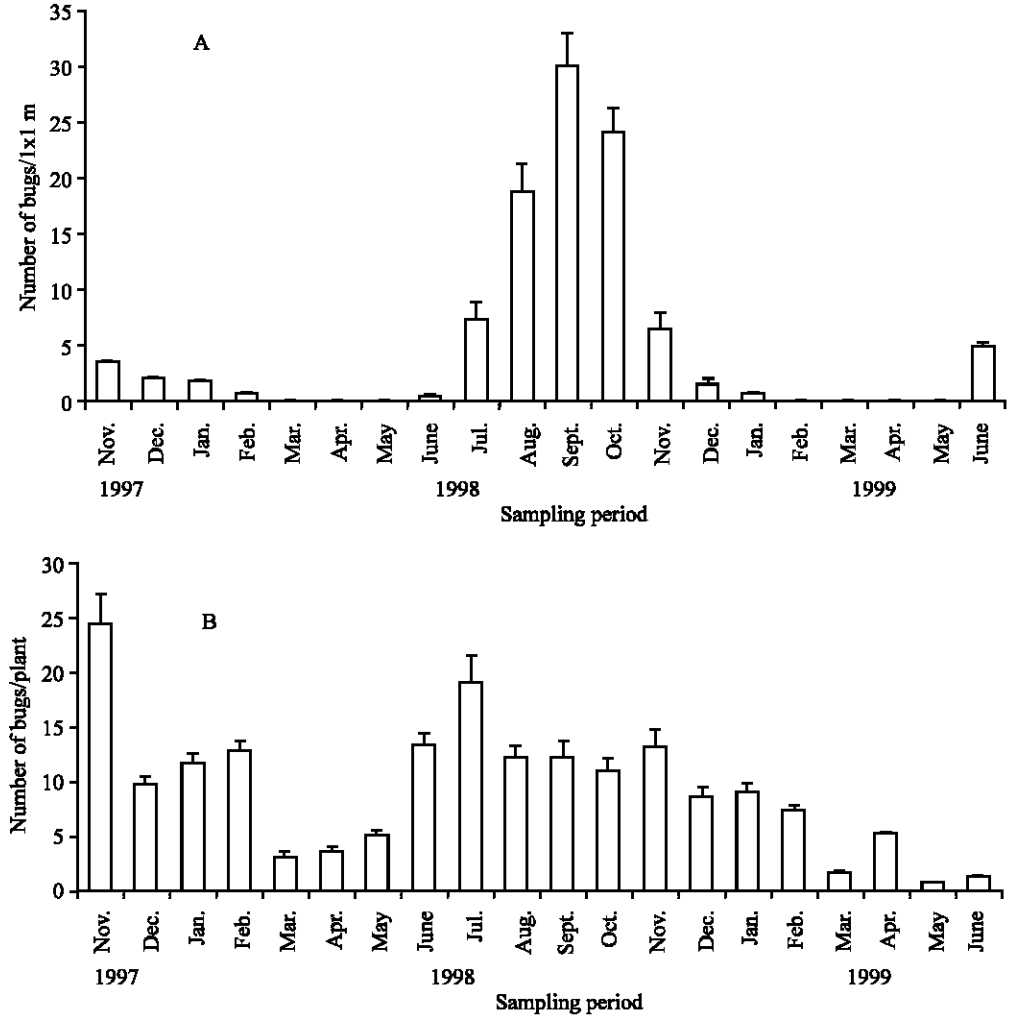


Fig. 1: Evolution of *C. tomentosicollis* adults population (Mean±SD) on the continuous crops of *V. unguiculata* (A) and *C. cajan* (B) during three years (1997-1999)

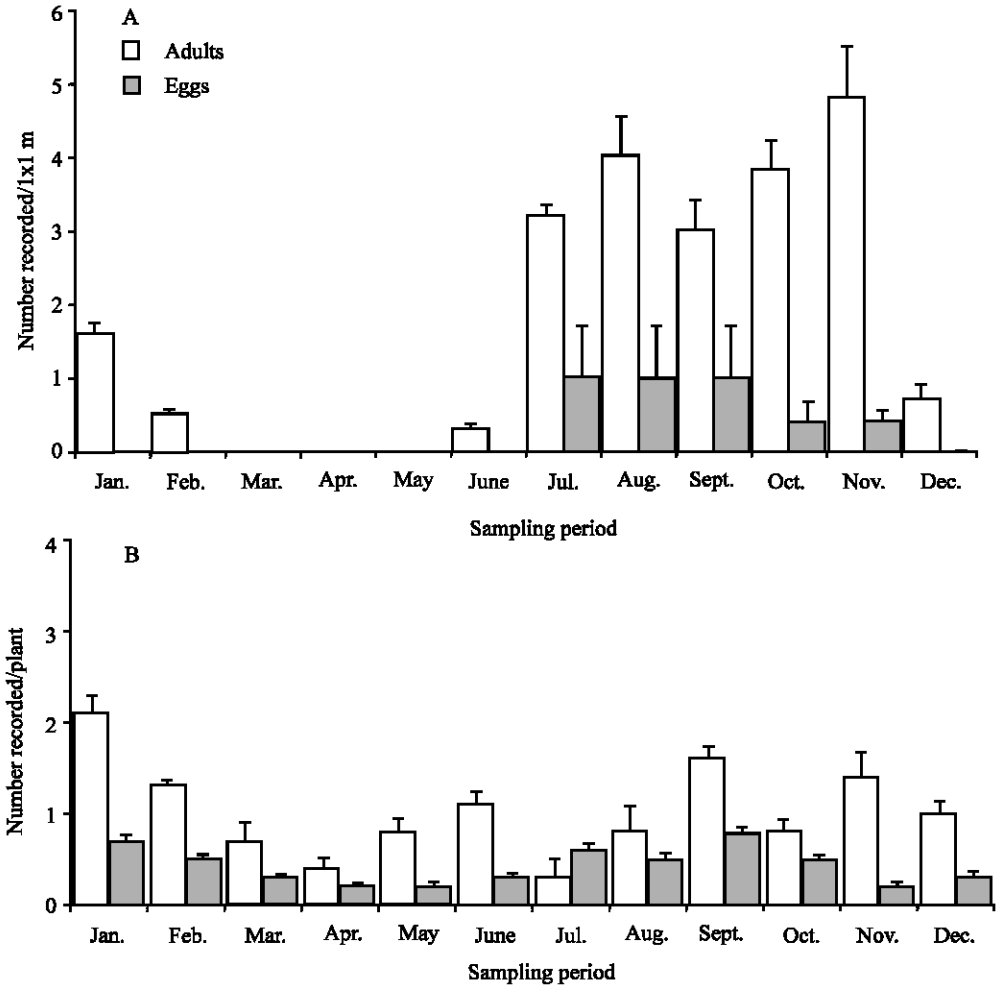


Fig. 2: Variation in *C. tomentosicollis* adults and eggs number (Mean±SD) on the continuous crops of *V. unguiculata* (A) and *C. cajan* (B) throughout the year (1999)

that 24 plant species, mainly legumes, could host the bug during off-season. They belong to eleven families of which Fabaceae is the most important with 45.8% of species. The other families are the *Malvaceae*, the *Lamiaceae*, the *Compositae*, the *Commelinaceae*, the *Rubiaceae*, the *Euphorbiaceae*, the *Amaranthaceae*, the *Capparidaceae*, the *Solanaceae* and the *Gramineae*.

**Development of *C. tomentosicollis* larvae on *Rhynchosia minima* L. pods and *Hibiscus esculentus* L. okro fruits:** *C. tomentosicollis* larvae were successfully reared on *R. minima* pods. Nevertheless, the larval survival rate, the larval development length and the growth index were slightly different from those observed on *V. unguiculata* pods (Table 2 and 3). On the opposite, *C. tomentosicollis* larvae could not complete their developmental cycle on *Hibiscus esculentus* L. fresh fruits (Table 3). The post-embryonic development stopped at the third larval stage. Although the three former larval instars could develop on okro fresh fruits the development duration of 2nd and 3rd instars larvae was significantly lengthened in comparison to the larvae reared on cowpea or even *R. minima* pods.

## DISCUSSION

During the rainy season, the cowpea plant offers *C. tomentosicollis* an oviposition and resting site (leaves) as well as a feeding substratum (pods). At cowpea flowering stage, adult insects migrate from their survival site (alternative host plants) towards crops. One or two generations develop there and the last one migrates at the end of cropping season which coincides with the beginning of dry season[2]. With the absence of bugs on

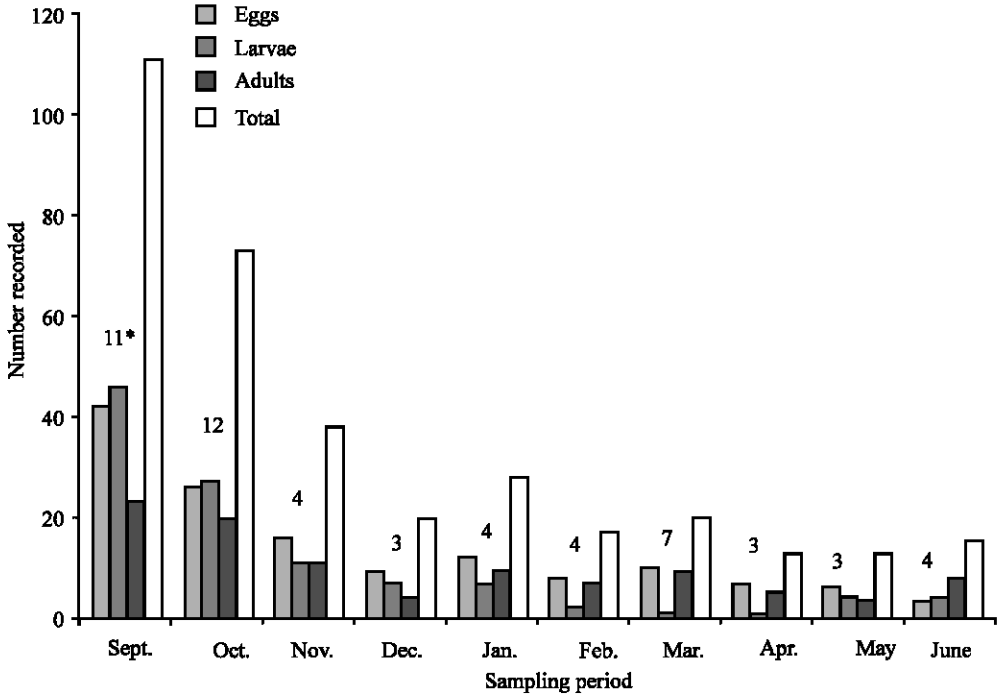


Fig. 3: Monthly variations in numbers of different developmental stages of *C. tomentosicollis* and its alternative host plants in dry season during the period of study (pooled data from 1997 to 1999). * indicates the number of alternative host plants found per month

cowpea at dry season, one could foresee the reduction of insecticide treatments on crops at that period if the crop can be cultivated by irrigation techniques.

All forms of *C. tomentosicollis* development (eggs, larvae and adults) were collected in important numbers on *Cajanus cajan*, *Rhynchosia memnonia* (Del.) DC., *R. minima* and *R. orthobothrya*, *Indigofera nigritana, I. pulchra*, *Canavalia* sp. at a given time in dry season. These plants could form the bug preferred hosts during off-season. As a matter of fact, the population of *C. tomentosicollis* was able to reproduce throughout the year and over years on *C. cajan*[11]. Furthermore, during the dry season this plant was preferred to cowpea as it had been already reported[12,13]. For this reason, some authors have investigated its use as trap plant to control *C. tomentosicollis* populations on cowpea[13,14]. Laboratory studies have also demonstrated that *R. minima* pods were suitable for *C. tomentosicollis* development and this finding supports its status of alternative host of the pest.

Another category of plants, in the cowpea field, made of *Acanthospermum hispidum*, *Borreria radiata*, *Commelina forskalaei*, *Lucas martinicensis* and *Tridax procumbens*, have hosted all the bug development stages but, only at end of rainy season, after exhaustion of cowpea pods. They are less common hosts than the others. The two *Crotalaria* species, *Pennisetum typhoides* (millet) and okro are temporal hosts on which, most often, only adult insects and eggs are found. They are the only plants with fresh fruits or pods (*Crotalaria* sp; okro) or with milky grains (millet) near cowpea plots at harvest. At the end of rainy season, adults migrate temporarily on these plants and it is likely that bugs cannot develop there continuously. Fed on these fruits, the fertilized female survives 21 days and does not lay egg[2].

Only one adult was collected on the upper part of tobacco leaf, during all the study. It is an accidental guest. In fact, it was demonstrated that adult bug transits on the upper face of cowpea leaves before migrating to another plant[15]. The insects use pods as feeding site and the lower face of leaves for resting[2].

The bug was also found on plants known for their insecticide or insect repellent properties such as *Hyptis spicigera*, *H. suaveolens* and *Tephrosia pedicellata* Bak. As surprising as it is, this observation is not an exception since *Tephrosia* sp. have already been identified as hosts of *C. tomentosicollis*[16].

The search of *C. tomentosicollis* host plants was the objective of many studies in Eastern and Southern Africa. The most common hosts in these zones are *Vigna unguiculata* Walp., *C. cajan*, *Lablab purpurens*

and *Phaseolus* sp.[12]. Studies in West Africa were limited to the Sudanian zone of Nigeria where no wild host plant of *C. tomentosicollis* was identified[2]. However, in the humid and forest zone, it was observed at least one bug development stage on *Eriosema psoraleoides*, *E. glomeratum*, *Cassia occidentalis*, *C. mimosoides* and *Crotalaria juncea*[7]. This study is the first in Sahelian zone. It shows that the bug survives in dry season and likely develops on a large spectrum of plants in the study zones. At the exception of *C. cajan*, *Crotalaria* sp. and *Tephrosia* sp., all the plants found to be alternative hosts of *C. tomentosicollis* were being identified for the first time. However, except for *R. minima*, their ability to enable full bug development remains to be confirmed by more specific studies.

The composition and temporal distribution analysis of residual bug populations shows that all the insect development stages are present on the majority of the host plants identified, from September to January. But, from February, the bug populations become less important with a predominance of eggs and adults. These results could be explained by the harshness of dry season with the very high temperatures observed as from March. Adults, resisting more to this hot weather and water stress, would be, during this period, the most common form for the insect to survive in nature[2]. The biological cycle of the bug can thus be summarized as follows: the development of 2 or 3 generations on cowpea in rainy season and the migration on secondary host plants namely *Rhynchosia* and *C. cajan* species in the dry season in Sahelian zone[2]. The assumption that bug reproductive activity stops at this period was also suggested[7]. Additional investigations are necessary to confirm the assumption in the Sahelian agro-climatic conditions, since bug mass production in laboratory had been carried out for several years. We also note a continuous development on *C. cajan* in natural conditions. The later case could be a secondary adaptation since this plant is not indigenous to the zone.

The importance of this study is that it answers the question on the origin of bug populations that invade cowpea fields every year. In fact, the dry season residual vegetation found in humid areas, lowlands or irrigated valleys include alternative host plants that hosts and favours bug development. It represents a real reservoir from which adult bugs migrate towards cowpea crop when its starts bearing pods. As part of the development of an integrated control method against this pest, pigeon pea could serve as a trap plant to protect the field. We could also recommend cowpea seed multiplication in dry season. Grain quality would improve because there would be no damages of pod sucking bugs and insecticide meant for treatment would be saved.

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