VOL. 8, NO. 10, OCTOBER 2013 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

# INVENTORY OF MAJOR INSECTS OF *Jatropha curcas* L. (EUPHORBIACEAE) AND THEIR NATURAL ENEMIES IN SOUTHERN BENIN

B. D. Datinon[1], A. I. Glitho[2], M. Tamò[1], K. Amevoin[2], G. Goergen[1], and O. K. Douro Kpindou[1]
[1]International Institute of Tropical Agriculture, Tripostal, Cotonou, Benin
[2]Laboratoire d'Entomologie Appliquée, Faculté des Sciences, Université de Lomé, Lomé, Togo
E-Mail : b.datinon@cgiar.org

**ABSTRACT**

Inventory of insects associated with *Jatropha curcas* L. (Euphorbiaceae) was conducted from June 2011 to May 2012 at 5 sites in southern and central Benin. Thirty-two major insect pests and 14 natural enemies, including 6 parasitoids and 8 predators, were recorded. The most important phytophagous species were *Stomphastis thraustica* (Meyrick) (Lepidoptera: Gracillariidae), *Aulacophora africana* (Weise) (Coleoptera: Chrysomelidae), *Altica* sp (Coleoptera: Apionidae), *Lagria villosa* (Fabricius) (Coleoptera: Lagriidae), *Paracoccus marginatus* Williams and Gramara de Willink (Hemiptera: Pseudococcidae), *Denticera* nr *divisella* (Duponchel) (Lepidoptera: Pyralidae), *Nezara viridula* (Linnaeus) (Hemiptera: Pentatomidae), *Calidea dregei* Germar (Heteroptera: Scutellaridae), and *Riptortus dentipes* Fabricius (Hemiptera: Alydidae). Almost all recovered parasitoids were obtained from caterpillars of *D.* nr *divisella;* a pest moth causes significant damage to flowers and young capsules of *J. curcas*. Within this guild the ichneumonid wasp *Syzeutus* nr *hessei* Benoit proved to be the most effective parasitoid against *D.* nr *divisella* in all 5 sites, with parasitism rate averaging 63%.

**Keywords:** *Jatropha curcas*, inventory, pests, parasitoids, natural enemies, Benin.

## INTRODUCTION

The adverse effects of global warming, caused by greenhouse gas emissions, on the environment are increasing. Consequently, the industry and transport sectors are seeking sources of renewable and cheaper sources of energy with fewer pollutants than gasoil (Gandonou, 2007; Jacquet *et al*., 2007).

Biofuels are seen as a solution to the problem of the depletion of fossil fuels and African countries are involved in the effort to realize the potentials of these alternative fuels. *Jatropha curcas* L. (Euphorbiaceae) is one of the most important plants used in tropical countries to produce biodiesel (Harsh *et al*., 2004). Its seeds contain 27-40% oil which is an excellent biofuel, lamp oil and a raw material for soap production (Heller, 1996). The seed cake is as fertilizer and can also be used for biogas production (Staubmann *et al*., 1997). The use of Jatropha oil as biodiesel has attracted the attention of governments and several initiatives are being taken to promote the development of the plant (Favre, 1997). However, the sustainable development of the use of *J. curcas* requires a thorough knowledge of the plant's agronomic characteristics, diseases and insect pests. Indeed, it has been suggested that the tropical climate favors the development of insect pests (Arodokoun, 1996).

The objective of this study was to establish an inventory of the insect pests of *J. curcas* and their natural enemies in the south and center of Benin for effective management of the production of this useful plant.

## MATERIAL AND METHODS

### Study sites

The study took place from June 2011 to May 2012 in 5 sites situated in the Department of the Zou in central Benin and Tori Calavi in Atlantic in southern Benin. Geo-localization data and site characteristics are provided in (Table-1).

**Table-1.** Geophysical characteristics of the study sites.

| Sites | District | Coordinates | Plots/ hedges | Climate | Seasons | Rainfall (mm) |
|---|---|---|---|---|---|---|
| IITA-Bénin station | Calavi | 6° 25'292N 2° 19'665E | Plots | humid Savannah | April-July | ≤900 |
| Tokan | | 6° 27'245N 2° 15'605E | Hedges | | | |
| Adja-Zounmè | Tori | 6° 30'11 N 2° 18' 42 E | Plots/ hedges | | August-September | ≤150 |
| Daanonkpota | Djidja | 07°13'483 N 2° 04'339 E | Plots/ hedges | dry Savannah | October-November | ≤200 |
| Ouakon-Zoungomè | Ouinhi | 7° 63' 709 N 2° 27'177 E | Plots/ hedges | | December-March | ≤170 |

## Methods

### Insects sampling

Field samples every month were taken for 12 months from June 2011 to May 2012. The inventory work were carried out on plots of 400 $m^2$ surface installed by IITA at Tori, Djidja and Ouinhi and hedges planted in villages Tori, Djidja, Ouinhi and Calavi (Table-1). Every site had four plots or hedges of Jatropha. Data collection consisted in visual observation of 30 randomly selected plants per plot of 400 $m^2$ and 30 randomly chosen plants per both within the plots and along hedge about of 1 year old. Samplings were doing on four plots and 4 lines of hedges per site. Within the plots, mobile entomofauna were collected with a sweep net and mouth. All insects were systematically recorded whether they were captured or only observed. Except for adult Lepidoptera that were kept in envelopes all collected insect specimens were separated by species and preserved in vials in 70% alcool. The 30 inflorescences collected in the field or hedge were incubated in Plexiglas boxes (ø = 18 cm, h = 6.5 cm) used for rearing insects in the laboratory. The rearing boxes were controlled every today.

### Counting of samples and identification of insects in the laboratory

From 4 to 5 days later and detected larva were then fed with the organs it was found to attack until pupation. All obtained pupae were transferred into Plexiglas (ø = 4.5cm, h = 4 cm) and reared to adults. Parasitoids emerging from the insects were collected and fed with honey. All species collected were labeled and identified before to integrate in the reference collection in the biodiversity centre at the International Institute of Tropical Agriculture (IITA) in Cotonou, Benin.

### Data analysis

Ecological parameters used to evaluate of each insect species were their frequency of occurrence (F), relative abundance (A) and density (D). The frequency of occurrence is expressed as the percentage samples in which a given species is found over the total number of samples taken (Alhmedi *et al*., 2007):

$$F = \frac{Pa}{P} \text{x } 100$$

Where, F = frequency of occurrence of the species
Pa = total number of samples containing the species
P = total number of samples, evaluated according to the interpretation by.

Dajoz (1985) distinguished four occurrence groups of species:

**Group-1:** Species that occur in 50% or more of samples
**Group-2:** Species that occur in 25-49% of samples
**Group-3:** Species that occur in 10 and 24% of samples
**Group-4:** Sporadic species which occur in less than 9% of samples

The relative abundance (A) of a species is the ratio of the number of individuals of the same species and the total number of individuals of all species:

$$A = \frac{Na}{Na + Nb + Nc + N \ldots} \text{x } 100$$

Where Na, Nb, Nc… are the numbers of individuals of species a, b, c….

The density (D) of a population is the number of live individuals of all species per unit area:

$$D = \frac{N}{P}$$

Where D is the density of the species; N is the total number of individuals of the species in the population; and P is the total number of samples collected from the population.

The rate of natural parasitism is the percentage of hosts parasitized by the parasitoid in nature.
It is calculated with the following formula:

$$TN = \frac{NP}{NL} X100$$

Where TN is the rate of natural parasitism; NP is the number of emerged parasitoids; and NL is the total number of larvae of the host brought to the laboratory.

All the above referred parameters were calculated using Minitab 14.

## RESULTS

### Diversity of insects collected at different sites

The insects collected during the study included 32 species that 1 on the stem, 15 on leaves, 4 on flowers and 12 on fruits (Table-2) and 14 species of natural enemies that 6 parasitoids and 8 predators. The major pests were Lepidoptera, Coleoptera, Orthoptera, Hemiptera, Isoptera and Thysanoptera.

### Frequency, abundance and density of pests

### Frequency of occurrence of pests

The ecological calculated indices (Table-3) show that *S. thraustica* (50.54% frequency on hedges and 40.71% in plots), *A. africana* (77.26% on hedges and 59.62% in plots), *D.* nr *divisella* (17.08% on hedges and 10.29% in plots), *P. marginatus* (19.62% on hedges and 18.82% in plots), *C. dregei* (19.06% on hedges and 12.29% in plots), and *N. viridula* (14.57% on hedges and 10.92% in plots) and *R. dentipes* (9.1% on hedges and 10.00% in plots).

### Relative abundance and density of pests

Table-3 shows that *S. thraustica* and *A. africana* are the most abundant species. *S. thraustica* has an

abundance of 17.69% with a density of 1.89 per plant on hedges against an abundance of 19.70% and a density of 1.52 in the plots. The abundance of *A. africana* is 11.38% with a density of 1.57 on the hedges against an abundance of 19.70% and a density of 1.41 in the plots.

**Diversity of natural enemies of major pests of J. curcas**

*D.* nr *divisella* is the main pest causing serious damage to flowers and young fruits of *J. curcas*. The following six parasitoid species were identified (Table-4): *Tachinid* sp. (Diptera Tachinidae); *Notanisomorphella* sp and *Cardiochiles rufithorax* Enderlein (Hymenoptera: Braconidae), *Exochus erythrinus* Holmgren, *Pristomerus* sp. and *Syzeuctus* nr *hessei* Benoit (Hymenoptera: Ichneumonidae). Eight species of predators that feed on insect eggs and larvae were caught on the plants (Table-4): *Stegodyphus* sp. (Acarina: Arachnidae); *Cheilomenes sulphurea* (Olivier) and *Exochomus troberti* Mulsant (Coleoptera: Coccinellidae); *Diaperasticus erythrocephalus* Olivier (Dermaptera: Forficulidae); *Sphodromantis* sp. (Dyctioptera: Mantidae); *Rhinocoris albopilosus* Signoret (Heteroptera: Reduviidae); and *Oecophylla* sp and *Camponotus sericeus* Fabricius (Hymenoptera: Formicidae)

*S.* nr *hessei* was observed at all sites at both hedges and in plots of *J. curcas* with parasitism rates of 11 to 63%. Parasitism by *Tachinid* sp. ranged from 0.8 to 29.4% (Table-5).

**Table-2.** Diversity of and damage by *Jatropha* pests in relation to the plant's growth stages.

| Order | Family | Species | Plant growth stage | Organs attacked | Damage |
|---|---|---|---|---|---|
| Coleoptera | Apionidae | *Apion* sp | Vegetative | Young leaves | Perforation |
| | Chrysomelidae | *Aulacophora africana* (Weise) | Vegetative | Young leaves | Perforation |
| | | *Barombiella* sp | Vegetative | Young leaves | Perforation |
| | | *Cryptocephalus* sp | Vegetative | Young leaves | Perforation |
| | | *Altica* sp | Vegetative | Young leaves | Perforation |
| | Lagriidae | *Lagria villosa* (Fabricius) | Vegetative | Young leaves | Perforation |
| | Meloidae | *Coryna hermanniae* (Fabricius) | Vegetative | Young leaves | Perforation |
| | | *Cylindrothorax westermanni* (Mäklin) | Vegetative | Young leaves | Perforation |
| | | *Decapotoma affinis* (Olivier) | Vegetative | Young leaves | Galeries |
| | Scarabaeidae | *Pachnoda cordata* (Drury) | Vegetative | Green fruits | Malformation |
| | Tenebrionidae | *Gonocephalum simplex* Fabricius | Vegetative | Young leaves | Perforation |
| | | *Praeugena marginata* (Fabricius) | Vegetative | Young leaves | Perforation |
| | | *Chrysolagria neavei* Burmeister | Vegetative | Young leaves | Perforation |
| Hemiptera | Aleyrodidae | *Bemisia tabaci* Gennadius | Vegetative | Young leaves | Sucking |
| | Coccidae | *Coccus viridis* Green | Vegetative | Terminal buds | Sucking |
| | Pseudococcidae | *Phenaccocus manihoti* Mat-Ferr | Vegetative | Soft parts and leaves | Sucking |
| | | *Paraccocus marginatus* Williams | Vegetative | Soft parts and leaves | Sucking |
| | Alydidae | *Riptortus dentipes* Fabricius | Fruiting | Fruits | Abortion |
| | Pentatomidae | *Nezara viridula* (Linnaeus) | Fruiting | Inflorescences | Abortion |
| | Coreidae | *Anoplocnemis tristator* Fabricius | Fruiting | Fruits | Malformation |
| | | *Pseudotheraptus devastans* Distant | Fruiting | Inflorescences | Abortion |
| | Miridae | *Helopeltis schoutedeni* Reuter | Fruiting | Flowers and fruits | Abortion |
| | Pyrrhocoridae | *Dysdercus voelkeri* Schmidt | Flowering | Flowers | Abortion |
| | Rhopalidae | *Leptocoris hexophthalma* Thunberg | Fruiting | Fruits | Abortion |
| | Scutellaridae | *Calidea dregei* Germar | Fruiting | Fruits | Abortion and malformation |
| Isoptera | Termitidae | *Macrotermes bellicosus* Smeathmann | All stages | Whole plant | Destruction |
| Lepidoptera | Gracillariidae | *Stomphastis thraustica* (Meyrick) | Vegetative | Chloroplast | Destruction |
| | Pyralidae | *Denticera* nr *divisella* (Duponchel) | Flowering and fruiting | Flowers, fruits and the apex of the plant | Destruction |
| | Tortricidae | *Archips occidentalis* (Walsingham) | Vegetative | Leaves | Destruction |
| Orthoptera | Pyrgomorphidae | *Zonocerus variegatus* (Linnaeus) | Vegetative | Leaves | Destruction |
| | Tettigoniidae | *Phaneroptera nana sparsa* Stål | Vegetative | Leaves | Perforation |
| Thysanoptera | Thripidae | *Scirtothrips kenyensis* Mound | Vegetative | Leaves | Sucking |

**Table-3.** Frequency of occurrence (F), relative abundance (A) and density (D) for all insect species on hedges and in plots at all sites.

| Insect species | **Frequency** (%) | | **Abundance** (%) | | **Density** (per plant) | |
|---|---|---|---|---|---|---|
| | **Hedges** | **Plots** | **Hedges** | **Plots** | **Hedges** | **Plots** |
| *A. africana* | 77.3 | 59.6 | 17.7 | 19.7 | 1.9 | 1.5 |
| *Altica sp.* | 39.4 | 32.8 | 8.2 | 5.5 | 0.6 | 0.6 |
| *Apion sp.* | 0.4 | 7.3 | 0.5 | 0.4 | 0.1 | 0.1 |
| *Barombiella sp.* | 2.7 | 8.1 | 1.7 | 0.3 | 0.1 | 0.4 |
| *C. hermanniae* | 0.0 | 6.2 | 0.4 | 0.0 | 0.0 | 0.1 |
| *Cryptocephalus sp.* | 1.9 | 1.9 | 0.1 | 0.2 | 0.1 | 0.1 |
| *C. neavei* | 5.1 | 6.0 | 0.4 | 0.6 | 0.1 | 0.1 |
| *C. westermanni* | 0.0 | 1.9 | 0.1 | 0.1 | 0.0 | 0.1 |
| *D. affinis* | 0.0 | 2.4 | 0.2 | 0.0 | 0.0 | 0.4 |
| *G. simplex* | 8.7 | 8.7 | 0.4 | 0.6 | 0.1 | 0.1 |
| *L. vilosa* | 22.2 | 28.9 | 3.9 | 3.7 | 0.3 | 0.4 |
| *P. marginata* | 4.8 | 4.8 | 0.3 | 0.4 | 0.1 | 0.1 |
| *P. cordata* | 3.2 | 6.1 | 1.4 | 0.6 | 0.1 | 0.3 |
| *M. bellicosus* | 1.4 | 1.3 | 0.8 | 1.0 | 0.1 | 0.1 |
| *A. occidentalis* | 0.6 | 0.8 | 0.2 | 0.4 | 0.1 | 0.2 |
| *D.* nr *divisella* | 17.1 | 10.3 | 2.9 | 6.3 | 0.9 | 0.6 |
| *S. thraustica* | 50.5 | 40.7 | 11.4 | 14.5 | 1.6 | 1.4 |
| *B. tabaci* | 0.0 | 4.0 | 0.0 | 2.1 | 0.0 | 0.4 |
| *C. viridis* | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| *P. manihoti* | 0.0 | 0.5 | 0.1 | 0.3 | 0.0 | 0.3 |
| *P. marginatus* | 19.6 | 18.8 | 8.0 | 6.5 | 1.2 | 0.5 |
| *A. tridator* | 4.4 | 2.7 | 0.3 | 0.6 | 0.1 | 0.1 |
| *C. dregei* | 19.1 | 12.3 | 4.6 | 2.8 | 0.5 | 0.3 |
| *D. voelkeri* | 0.6 | 7.1 | 0.7 | 0.5 | 0.1 | 0.1 |
| *H. schoutedeni* | 6.9 | 9.6 | 0.6 | 0.9 | 0.1 | 0.1 |
| *L. hexophthalma* | 5.8 | 6.2 | 0.6 | 0.6 | 0.1 | 0.1 |
| *N. viridula* | 14.6 | 10.9 | 1.8 | 5.6 | 0.2 | 0.3 |
| *P. devastans* | 0.4 | 7.1 | 1.9 | 0.3 | 0.1 | 0.3 |
| *R. dentipes* | 9.1 | 10.0 | 0.6 | 0.7 | 0.0 | 0.1 |
| *P. nana sparsa* | 0.9 | 1.7 | 0.1 | 0.2 | 0.1 | 0.3 |
| *Z. variegatus* | 1.8 | 1.9 | 1.1 | 0.6 | 1.5 | 0.9 |
| *S. kenyensis* | 6.5 | 9.1 | 1.2 | 2.5 | 0.3 | 0.4 |

**Table-4.** Natural enemies collected on insects feeding on *J. curcas.*

| Orders, families, and species of natural enemies | Hosts: Species parasitized | Hosts: Stage parasitized |
|---|---|---|
| **Parasitoids** | | |
| Diptera | | |
| Tachinidae | | |
| *Tachinid* sp. | *D.* nr *divisella* | Larvae |
| Hymenoptera | | |
| **Braconidae** | | |
| *Notanisomorphella* sp. | *S. thraustica* | Larvae |
| Ichneumonidae | | |
| *Cardiochiles rufithorax* Enderlein | *D.* nr *divisella* | Larvae |
| *Exochus erythrinus* Holmgren | *D.* nr *divisella* | Larvae |
| *Pristomerus* sp. | *D.* nr *divisella* | Larvae |
| *Syzeuctus* nr *hessei* Benoit | *D.* nr *divisella* | Larvae |
| **Predators** | | |
| Acarina | | |
| Arachnidae | | |
| *Stegodyphus* sp. | - | - |
| Coleoptera | | |
| Coccinellidae | | |
| *Cheilomenes sulphurea* (Olivier) | - | - |
| *Exochomus troberti* Mulsant | - | - |
| Dermaptera | | |
| Forficulidae | | |
| *Diaperasticus erythrocephalus* Olivier | - | - |
| Dyctiopetera | | |
| Mantidae | | |
| *Sphodromantis* sp | - | - |
| Heteroptra | | |
| Reduviidae | | |
| *Rhinocoris albopilosus* Signoret | - | - |
| Hymenoptera | | |
| Formicidae | | |
| *Oecophylla* sp | - | - |
| *Camponotus sericeus* Fabricius | - | - |

**Table-5.** Rate of parasitism on *D.* nr *divisella* and *S. thraustica* larvae collected from hedges and plots.

| Sites | Parasitism rate | | | | | |
|---|---|---|---|---|---|---|
| | on *D.* nr *divisella* | | | | | on *S. thraustica* |
| | ***S.*nr *hessei*** | ***Tachinid* sp.** | ***Pristomerius* sp.** | ***A. rufithoras*** | ***E. erythrinus*** | ***Notanisomorphella* sp.** |
| Calavi hedge | 37.2 | 0.8 | 4.5 | 8.0 | 10.3 | 0.0 |
| Djiaja plot | 63.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Djidja hedge | 57.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| IITA plot | 52.2 | 0.0 | 0.0 | 0.0 | 0.0 | 6.1 |
| Ouinhi plot | 0.0 | 29.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ouinhi hedge | 11.9 | 8.4 | 1.3 | 3.3 | 2.7 | 0.7 |
| Tori plot | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Tori hedge | 39.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

## DISCUSSIONS

The results of this insect inventory revealed that several species belonging to six orders of insects occur on *J. curcas* in hedges and plots. They were apparently able to overcome the natural insecticidal toxicity of *J. curcas* (El-Badawi *et al*., 1995; Gadir *et al*., 2003; Rakshit *et al*., 2010). Termites building the veneers on jatropha plants and cause extensive damage by destroying the collar of jatropha tree and making them fall as they lose their toughness. Akpesse *et al*. (2008) reported that some species of termites were frequently encountered on the stems of *J. curcas* and are responsible for the damage observed. The most important defoliators encountered on *J. curcas* are *S. thraustica*, *A. africana, Altica* sp., and *L. vilosa*. The presence of these defoliators is very remarkable in plantations and they cause significant damage to plants at the vegetative stage. A severe attack by the rootworm, *A. africana*, significantly reduces the physiological activity of the plant as it punctures small holes in the leaves of seedlings. This causes rapid drying and wilting of the plants (Acker *et al*., 1997; Assogbadjo *et al*., 2009; Ahoton *et al*., 2011; Gandonou *et al*., 2012). The leaf miner, *S. thraustica,* feeds on cellulose in the leaves, especially at the vegetative stage, and forms mines which appear as dry spots which may be confused with disease (Smet, 2011). The mealybug *P. marginatus,* is a serious pest *J. curcas* in plantations in our study area, thus confirming the observations of Galanihe *et al*. (2010) and Regupathy and Ayyasamy (2011). The most formidable pest observed in plantations *J. curcas* is the butterfly *D.* nr *divisella* (Durairag *et al*., 1999; Shanker and Dhyani, 2006; Smet, 2011). It bores into flowers and young capsules and thereby causes serious damage by the destruction of the plant's apex and inflorescences. The females lay eggs on the leaves and the young larvae weave silk over the apex, flowers and young fruits. The larvae feed on the young leaves at the apex and flowers before tackling green fruit and destroying the seeds. These infestations of *D.* nr *divisella* were reported to be the major pest of *Euphorbia antisyphilica* in the arid zones (Singh *et al*., 1996). They pierce the stems along which they dig galleris (Shanker and Dhyani, 2006; Smet, 2011). Indeed, as reported earlier by Omotoso (2005) and Egho, (2011), we observed that *C. dregei*, *N. viridula* and *R. dentipes* cause flowers and young fruits to borty and seed malformation. *C. dregei* appears frequently during the rainy season (Bijlmakers and Verhoek, 1995).

The parasitoid *S.* nr *hessei* was present on *D.* nr *divisella* at all survey sites and had the highest rate of parasitism. The potential of this parasitoid for the biocontrol of this devastating caterpillar needs to be studied. Several predators, including *Stegodyphus* sp., *C. sulphurea* and *Sphodromantis* sp., were found attacking insect pests in *J. curcas* plantations, thus confirming the work of Gabriel *et al.* (1988). The weaver ants, *O. longinoda* are generalist predatory that feed on the honeydew exudate of mealybugs as well as on the larvae of Diptera, Coleoptera and Hymenoptera (Dejean, 1991, Peng *et al*., 1995; Kenne *et al*, 2003, Césard, 2004). The ladybird bettles *C. sulphurea* and *E. troberti* are often encountered in agriculture reducing the pest population by consuming their eggs and larvae (Hodek *et al*., 2012). Similarly, D. *erythrocephalus*, *R. albopilosus* and *C. sericeus* are important biological control agents against insect pests in plantations (Wheeler, 1959; Aroga and Coderre, 2001 and Thomas and Aswathi, 2012).

## CONCLUSIONS

The erroneous widespread belief that the toxic insecticidal properties of *J. curcas* provide immunity against insect attack may have a negative impact on the productivity of plantations. Indeed, several groups of insects have overcome this barrier of natural resistance and pose a real problem for farmers. This survey of the entomofauna of *J. curcas* in Benin recorded 32 insect species among which the main pests are *A. africana*, *S. thraustica*, *Altica* sp., *L. vilosa*, *D.* nr *divisella*, *P. marginatus*, *N. viridula*, *C. dregei* and *R. dentipes.* However, *S. thraustica* and *A. africana* are the most abundant. Since Jatropha farmers in Benin lack the means to adequately control these pests, there is an urgent need to develop environmentally sustainable control measures. It is recommended that the use of the parasitoid *S. hessei* in the biological control of *D.* nr *divisella* be considered.

## ACKNOWLEDGEMENTS

The authors thank Omate Togbossy, Alexander Fassinou and Anatole Hountongninou for their assistance in the completion of this study. They also thank the officials of the Jatropha Project and the Embassy of the Netherlands in Benin for their financial assistance.

## REFERENCES

Acker CL, Giibitz CG, Mittelbach M and Trabi M. 1997. Growth and reproduction of *J. curcas.* In: Biofuels and Industrial Productions from *Jatropha curcas*. (Eds), DBV Graz. 2-18.

Ahoton LE, Quenum F and Mergeai G. 2011. Evaluation and selection of the best agromorphological accessions of Jatropha (*Jatropha curcas* L.) introduced in Benin. Int. J. Biol. Chem. Sci. 5(4): 1619-1627.

Akpesse AA, Kouassi PK, Tano Y and Lepage M. 2008. Impact of the termites in farmers' fields of rice and maize in sub-Sudan savanna (Booro-Borotou, Côte-d'Ivoire). Sciences and Nature. 5: 121-131.

Alhmedi A, Francis F, Bodson B and Haubruge E. 2007. Assessment of the diversity of aphids and their natural enemies in crop fields near nettles. Notes wildlife Gembloux. 60(4): 147-152.

Aroga R and Coderre D. 2001. Effects of temperature on the development and fecundity of *Diaperasticus erythrocephala* Olivier (Dermaptera: Forficulidae). Insect Science and its Application. 21(2): 161-167.

Arodokoun DY. 1996. Importance of alternative host plants and indigenous natural enemies in biological control of *Maruca testulalis* (Geyer). PhD Thesis, Faculty of Science and Engineering. Université Laval. Quebec, Canada. p. 167.

Assogbadjo AE, Amadji G, Glèlè Kakaï R, Mama A, Sinsin B and Van Damme P. 2009. Ecological assessment and ethnobotany of *Jatropha curcas* L. in Benin. Int. J. Biol. Chem. Sci. 3(5): 1065-1077.

Bijlmakers HWL and Verhoek BA. 1995. Guide to crop protection in Chad, crops and Vegetables Fresh, FAO/PNUD CHD/88/001. p. 416.

Césard N. 2004. Kroto *(Oecophylla smaragdina)* Malingping area, West Java, Indonesia: collection and marketing of significant animal resource. Anthropozoologica. 39(2): 15-31.

Dajoz R. 1985. Precise Ecology. Ed. Bordas. Paris. p. 505.

Dejean A. 1991. Adaptation of *Oecophylla longinoda* [Formicidae-Formicinae] spaciotemporelles variations in the density of prey. Entomophaga. 36(1): 29-54.

Durairaj S, Srinivasan G, Balu A, Deeparaj B and Raja Rishi R. 1999. Ecofriendly methods of control the *Jatropha* shoot and fruit borer *Sciota divisella* (Duponchel) (Lepidoptera: Pyralidae). Paper presented in the National symposium on biological control of insects in Agriculture, Forestry, Medicine and Veterinary Science, 21 January at Bharathiyar University.

Egho EO. 2011. The potentials of mineral oils for controlling the major insect pests of cowpea (*Vigna unguiculata* (L.) Walp in Asaba, Nigeria. Agriculture and Biology Journal of North America. 2(3): 454.

El-Badawi SM, Adam SE and Hapke HJ. 1995. Comparative toxicity of *Ricinus communis* and *Jatropha curcas* in Brown Hisex chicks. Dtsch. Tierärztl. Wochenschr. 102: 75-77.

Favre D. 1997. Neuroscience in Education Sciences: contribution to epistemology year of variance. PhD in Sciences of Education, University of Lyon 2, University Press of North. p. 433.

Gabriel D, Calcagnolo G, Tancini RS, Dias Netto N, Petinelli JrA and Araujo JBM. 1988. Pests and natural enemies of *Jatropha curcas*. A, *Scutellera nobilis* inserting stylet. Biologico. 54, 17-20.

Gadir A, Onsa TO, Ali WEM, El-Badawi SMA and Adam SEI. 2003. Comparative toxicity of *Croton macrostachys*, *Jatropha curcas*, *Piper abyssinica* seeds in Nubian goats. Small Rum. Res. 48:61-67.

Galanihe LD, Jayasundera MUP, Vithana A, Asselaarachchi N and Watson GW. 2010. Occurrence, distribution and control of papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae), an invasive alien pest in Sri Lanka. Tropical Agricultural Research and Extension. 13(3): 81-86.

Gandonou C. 2007. What is the situation of Biofuels in West Africa? Seeds of biodiversity, No. 66 (August 007): 1-2. (Available on the website: http://www.grain.org/semences_files/note-66-fr.pdf).

Gandonou ChB, Houmba LNR, Ahoton E, Desquilbet S, Fakambi K, Datinon B and Marshall E. 2012. Evaluation of the emergence and growth in twelve accessions of *Jatropha curcas* in Benin, Bulletin of Agricultural Research of Benin (72) ISSN: 1025-2355**,** http://www.slire.net.

Harsh LN, Tewari JC, Khan HA and Bohra A. 2004. Agronomic practices for cultivation of *Jatropha curcus*-a biodiesel plant in arid region. In: national conference on Bio-diesel for IC Engine-Technologies and strategies for Reveal application. Held at CIAE Bhopal on 3-5 December.

Heller J. 1996. Physic nut *Jatropha curcas* L. Promoting the conservation and use of underutilized and neglected crops. 1. Institute of Plant Genetics and Crop Plant Research / International Plant Genetic Resources Institute. p. 66.

Hodek I, Honek A, and Emden HFV. 2012. Ecology and Behaviour of the Ladybird Beetles (Coccinellidae). ISBN: 978-1-4051-8422-9. p. 604.

Jacquet L, Bamiere L, Bureau JC and Guinde L. 2007. Potential in biofuels in the European Union. Available on www.larevuedurable.com/editions/29.1PhP.

Kenne M, Djieto-lordon C, Orivel J, Mony R, Fabre A and Dejean A. 2003. Influence of insecticide treatments or ant-Hemipteran association in tropical plantation. Journal of Economic Entomology. 96: 251-258.

Omotoso OT. 2005. Comparative studies of the susceptibility of the pods of selected varieties of cowpea to *Riptortus dentipes* Fabricuis and *Anoplocnemis curvipes* Fabricius (Heteroptera). Applied Zoology and Environmental Biology. 7: 106-111.

Peng R K, Christian K and Gibb K. 1995. The effect of the green ant, *Oecophylla* (Hymenoptera: Formicidae), on insect pests of cashew trees in Australia. Bull. Entomol. Res. 85: 279-284.

Regupathy A and Ayyasamy R. 2011. Ants in biofuel, *Jatropha* Ecosytem: pollination and phoresy, *Hexapoda.* 18: 168-175.

Shanker C and Dhyani SK. 2006. Insect pests of *Jatropha curcas* L. and potential for their management. National Research Centre for Agroforestry, Gwalior Road, Jhansi 284 003, India. p. 162.

Singh MP. and Harsh LN. 1996. *Denticera divisella* Duponechal (Pyralidae: Lep) infesting *Euphorbia antisyphilitica* in the arid zones. Entomon. 21 (3 and 4): 263-264.

Smet J. 2011. Evaluation of parasite pressure on *Jatropha curcas.* Water-Energy Program EESF solidarity Foundiougne. p. 4.

Staubmann R, Foidl G, Foidl N, Lafferty RM, Valencia Arbizu VM and Steiner W. 1997. Production of Biogas from *Jatropha curcas* Seeds Press Cake. In: Applied Biochemistry and Biotechnology /A 63 5, S, 457-467.

Rakshit K, Devappa HPS and Makkar KB. 2010. *Jatropha* toxicity-a review. Institute for Animal Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, Germany. Journal of Toxicology and Environmental Health, Part B. 13: 476-507.

Thomas SK and Aswathi P. 2012. Potential of rubber litter dwelling ants as biocontrol agent of home invading nuisance pest, *Lupropos tristis*, JBbiopest, 5(Supplementary): 188-191.

Wheeler WM. 1959. An account of parental care in *Rhinocoris albopilosus* Signoret (Hemiptera-Heteroptera: Reduviidae), with notes on its life history. Proceedings of the Royal Entomological Society of London. 34: 175-185.