



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

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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: Scutelleridae), 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 *Syzeuctus 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	dry Savannah	August- September	≤150
Daanonkpota	Djidja	07° 13' 483 N 2° 04' 339 E	Plots/ hedges		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 m² 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 m² 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 micro aspirator. 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% alcohol. 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):

$$F = \frac{Pa}{P} \times 100$$

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:

$$A = \frac{Na}{Na + Nb + Nc + N \dots} \times 100$$

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:

$$TN = \frac{NP}{NL} \times 100$$

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	<i>Apion</i> sp.	Vegetative	Young leaves	Perforation
	Chrysomelidae	<i>Aulacophora africana</i> (Weise)	Vegetative	Young leaves	Perforation
		<i>Barombiella</i> sp.	Vegetative	Young leaves	Perforation
		<i>Cryptocephalus</i> sp.	Vegetative	Young leaves	Perforation
		<i>Altica</i> sp.	Vegetative	Young leaves	Perforation
	Lagriidae	<i>Lagria villosa</i> (Fabricius)	Vegetative	Young leaves	Perforation
	Meloidae	<i>Coryna hermanniae</i> (Fabricius)	Vegetative	Young leaves	Perforation
		<i>Cylindrothorax westermanni</i> (Mäklin)	Vegetative	Young leaves	Perforation
		<i>Decapotoma affinis</i> (Olivier)	Vegetative	Young leaves	Galleries
	Scarabaeidae	<i>Pachnoda cordata</i> (Drury)	Vegetative	Green fruits	Malformation
	Tenebrionidae	<i>Gonocephalum simplex</i> Fabricius	Vegetative	Young leaves	Perforation
		<i>Praeugena marginata</i> (Fabricius)	Vegetative	Young leaves	Perforation
		<i>Chrysolagria neavei</i> Burmeister	Vegetative	Young leaves	Perforation
Hemiptera	Aleyrodidae	<i>Bemisia tabaci</i> Gennadius	Vegetative	Young leaves	Sucking
	Coccidae	<i>Coccus viridis</i> Green	Vegetative	Terminal buds	Sucking
	Pseudococcidae	<i>Phenacoccus manihoti</i> Matile-Ferrero	Vegetative	Soft parts and leaves	Sucking
		<i>Paracoccus marginatus</i> Williams	Vegetative	Soft parts and leaves	Sucking
	Alydidae	<i>Riptortus dentipes</i> Fabricius	Fruiting	Fruits	Abortion
	Pentatomidae	<i>Nezara viridula</i> (Linnaeus)	Fruiting	Inflorescences	Abortion
	Coreidae	<i>Anoplocnemis tristator</i> Fabricius	Fruiting	Fruits	Malformation
		<i>Pseudothraupis devastans</i> Distant	Fruiting	Inflorescences	Abortion
	Miridae	<i>Helopeltis schoutedeni</i> Reuter	Fruiting	Flowers and fruits	Abortion
	Pyrrhocoridae	<i>Dysdercus voelkeri</i> Schmidt	Flowering	Flowers	Abortion
	Rhopalidae	<i>Leptocoris hexophthalma</i> Thunberg	Fruiting	Fruits	Abortion
Isoptera	Termitidae	<i>Macrotermes bellicosus</i> Smeathmann	All stages	Whole plant	Destruction
	Gracillariidae	<i>Stomphastis thraustica</i> (Meyrick)	Vegetative	Chloroplast	Destruction
	Pyrilidae	<i>Denticera nr divisella</i> (Duponchel)	Flowering and fruiting	Flowers, fruits and the apex of the plant	Destruction
Orthoptera	Tortricidae	<i>Archips occidentalis</i> (Walsingham)	Vegetative	Leaves	Destruction
	Pyrgomorphidae	<i>Zonocerus variegatus</i> (Linnaeus)	Vegetative	Leaves	Destruction
	Tettigoniidae	<i>Phaneroptera nana sparsa</i> Stål	Vegetative	Leaves	Perforation
Thysanoptera	Thripidae	<i>Scirtothrips kenyanensis</i> 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
<i>A. africana</i>	77.3	59.6	17.7	19.7	1.9	1.5
<i>Altica sp.</i>	39.4	32.8	8.2	5.5	0.6	0.6
<i>Apion sp.</i>	0.4	7.3	0.5	0.4	0.1	0.1
<i>Barombiella sp.</i>	2.7	8.1	1.7	0.3	0.1	0.4
<i>C. hermanniae</i>	0.0	6.2	0.4	0.0	0.0	0.1
<i>Cryptocephalus sp.</i>	1.9	1.9	0.1	0.2	0.1	0.1
<i>C. neavei</i>	5.1	6.0	0.4	0.6	0.1	0.1
<i>C. westermanni</i>	0.0	1.9	0.1	0.1	0.0	0.1
<i>D. affinis</i>	0.0	2.4	0.2	0.0	0.0	0.4
<i>G. simplex</i>	8.7	8.7	0.4	0.6	0.1	0.1
<i>L. vilosa</i>	22.2	28.9	3.9	3.7	0.3	0.4
<i>P. marginata</i>	4.8	4.8	0.3	0.4	0.1	0.1
<i>P. cordata</i>	3.2	6.1	1.4	0.6	0.1	0.3
<i>M. bellicosus</i>	1.4	1.3	0.8	1.0	0.1	0.1
<i>A. occidentalis</i>	0.6	0.8	0.2	0.4	0.1	0.2
<i>D. nr divisella</i>	17.1	10.3	2.9	6.3	0.9	0.6
<i>S. thraustica</i>	50.5	40.7	11.4	14.5	1.6	1.4
<i>B. tabaci</i>	0.0	4.0	0.0	2.1	0.0	0.4
<i>C. viridis</i>	0.0	0.1	0.1	0.0	0.0	0.0
<i>P. manihoti</i>	0.0	0.5	0.1	0.3	0.0	0.3
<i>P. marginatus</i>	19.6	18.8	8.0	6.5	1.2	0.5
<i>A. tridator</i>	4.4	2.7	0.3	0.6	0.1	0.1
<i>C. dregei</i>	19.1	12.3	4.6	2.8	0.5	0.3
<i>D. voelkeri</i>	0.6	7.1	0.7	0.5	0.1	0.1
<i>H. schoutedeni</i>	6.9	9.6	0.6	0.9	0.1	0.1
<i>L. hexophthalma</i>	5.8	6.2	0.6	0.6	0.1	0.1
<i>N. viridula</i>	14.6	10.9	1.8	5.6	0.2	0.3
<i>P. devastans</i>	0.4	7.1	1.9	0.3	0.1	0.3
<i>R. dentipes</i>	9.1	10.0	0.6	0.7	0.0	0.1
<i>P. nana sparsa</i>	0.9	1.7	0.1	0.2	0.1	0.3
<i>Z. variegatus</i>	1.8	1.9	1.1	0.6	1.5	0.9
<i>S. kenyensis</i>	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	Stage parasitized
Parasitoids		
Diptera		
Tachinidae		
<i>Tachinid</i> sp.	<i>D. nr divisella</i>	Larvae
Hymenoptera		
Braconidae		
<i>Notanisomorphella</i> sp.	<i>S. thraustica</i>	Larvae
Ichneumonidae		
<i>Cardiochiles rufithorax</i> Enderlein	<i>D. nr divisella</i>	Larvae
<i>Exochus erythrinus</i> Holmgren	<i>D. nr divisella</i>	Larvae
<i>Pristomerus</i> sp.	<i>D. nr divisella</i>	Larvae
<i>Syzeuctus nr hessei</i> Benoit	<i>D. nr divisella</i>	Larvae
Predators		
Acarina		
Arachnidae		
<i>Stegodyphus</i> sp.	-	-
Coleoptera		
Coccinellidae		
<i>Cheilomenes sulphurea</i> (Olivier)	-	-
<i>Exochomus troberti</i> Mulsant	-	-
Dermaptera		
Forficulidae		
<i>Diaperasticus erythrocephalus</i> Olivier	-	-
Dyctiopetera		
Mantidae		
<i>Sphodromantis</i> sp.	-	-
Heteroptera		
Reduviidae		
<i>Rhinocoris albopilosus</i> Signoret	-	-
Hymenoptera		
Formicidae		
<i>Oecophylla</i> sp.	-	-
<i>Camponotus sericeus</i> Fabricius	-	-

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

Sites	Parasitism rate					
	on <i>D. nr divisella</i>					on <i>S. thraustica</i>
	<i>S. nr hessei</i>	<i>Tachinid</i> sp.	<i>Pristomerus</i> sp.	<i>A. rufithorax</i>	<i>E. erythrinus</i>	<i>Notanisomorphella</i> 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 antispyphilica* 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 beetles *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.

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