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Research Article

HOST PLANTS OF THE MANGO MEALYBUG *RASTROCOCCUS INVADENS* WILLIAMS (HOMOPTERA: PSEUDOCOCCIDEA) IN WESTERN BURKINA FASO

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A B S T R A C T

Rastrococcus invadens Williams is one of the main constraints of mango production in Western Burkina Faso. This insect pest has already caused serious damage to the mango industry since it invaded Africa in 1980's. Its damages were as reported on other economically important fruits crop, vegetables, and ornamental plants. The objective of this study, carried out in Western Burkina Faso during two consecutive seasons (dry and rainy), was to establish the host plants of the mango mealybug. Thus, twenty orchards were surveyed in fifteen locations. The inventory was conducted on a radius of 200m along the diagonal of each orchard. The level of infestation of the insect pest was assessed on the leaves or on the stem, depending on the type of tree. Beside the mango tree, 40 host plants of the insect pest, belonging to 24 families, were found. These host plants included fruit crops, food crops, ornamental plants, vegetables, weeds, wild plants and timber species. *Vitex doniana*, *Khaya senegalensis*, *Musa sapientum*, *Passiflora sp.*, *Vitellaria paradoxa*, *Citrus limon*, *C. tangelo* and *Tectona grandis* were the most infested species by the insect pest. Fruit crops, weeds and wild plants were predominant in the frequencies of infestation compared to the other host plants. The establishment of the host range of *R. invadens* will improve strategies to control this pest in Burkina Faso and limit its spread to other area of the country.

INTRODUCTION

The mango mealybug is an insect pest that was accidentally introduced in Africa from South-East Asia. It was observed for the first time in the 1980s in Ghana and in Togo (Moore, 1992). Since that period, the distribution area of the insect pest progressively expended and covered most of Western and Central African countries (Neuschwander *et al*., 1994). This phenomena was probably fostered by inter country trade and by the exchange of contaminated plant materials. The pest has caused serious damages on mango and other fruit trees in Africa. In Ghana, mango and avocado exports values fell from US $ 150,000 to US $ 22,000 between 1985 and 1986 due to infestations of *R. invadens* (Willink and Moore, 1988). According to Tobih and al. (2002), the fresh weight of mangoes can be reduced by about 51% on infested trees. The level of certain nutrients is also affected (Tobih *et al*., 2002; Pitan *et al*., 2002). Yield losses of 50% and 100% were respectively recorded in research station and in the field in the North of the Ivory-Cost (Hala *et al*., 2004).

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Several other host plants of the insect pest were indexed in most countries where the mango mealybug was reported. Thus, the insect pest was identified in Togo and in Benin on 44 plant species belonging to 22 families (Moore, 1992). These plants included fruit trees and shading trees, wild plants and ornamental plants, vegetables, food crops and timber-trees. In Dakar (Senegal), the pest was observed on 13 plant species (Han *et al*., 2007). In Nigeria, *R. invadens* was reported on 20 host plants of 12 families (Ivbijaro *et al*., 1992) with a peculiar presence on only *Mangifera indica* and *Ficus thoningii* in the South Guinean savannah of the country (Akintola and Ande, 2009). The introduction of the mango mealybug in Burkina Faso is dated back to the years 2000 (Dabiré *et al*., 2002; Hala *et al*., 2004). The first alerts were reported at the border between Burkina Faso and Ivory-Cost. In 2009, the pest was found in 24 locations circumscribed in the West of the county (Dakouo *et al*., 2011). The same authors reported that the mango mealybug is the second major constraint of mango production in this zone which provides nearly 75% of the national production of that fruit. According to Ouédraogo *et al*. (2011), mango represents the major fruit crop with 55.8% of the total production. Ecology of *R. invadens*, based on host

plants range is not known in Burkina Faso particularly in its distribution area. The host plants support the pest's populations and represent potential sources that mitigate the efficiency of control methods. In addition, host plants favorite the spread of the pest in relationship with certain abiotic factors and human action. Knowing the pest host plants range could help growers in the adoption of agricultural practices such as the uprooting of alternative host plants within and around their orchards. This study was therefore undertaken to establish the host range of the mango mealybug in Western Burkina Faso.

MATERIAL AND METHODS

Sites of study

The study was implemented in the distribution area of mango mealybug mapped out by Dakouo *et al*. (2011). That zone is bordered in the West by Mali and in the South by Côte-d'Ivoire; in the North and East by the Banwa, Tuy, Bougouriba and Poni provinces. It is characterized by a Sudanian climate type and a rainy season of 5 to 6 months from May to October. The annual rainfall varied between 1020 and 1246.2 mm depending on the areas surveyed. The temperature was low in the rainy season (25 to 26°C) and high (29 to 32°C) in the dry season. As for relative humidity, it was high (81-87%) in rainy season and low (39 to 41%) in dry season. Eleven 'hot spots' previously indexed in the distribution area of the insect pest and 5 other newly invaded ones were covered by the study (Figure 1). In these locations, infestations of the mango mealybug are mostly observed in the orchards near population aggregates and near road infrastructures. Thus, 20 mango orchards were prospected, that was 18 near population aggregates and 2 in the field. A first survey was carried out during the dry season (April 2014). Because of plants' diversity, including weeds and food crops in the rainy season, 6 orchards out of the 20 were revisited from August to October 2014. Several food crops were sown in some orchards. These included cowpea, tomato, groundnut, okra and maize. Table 1 informs on the number of orchards and on the prospection period.

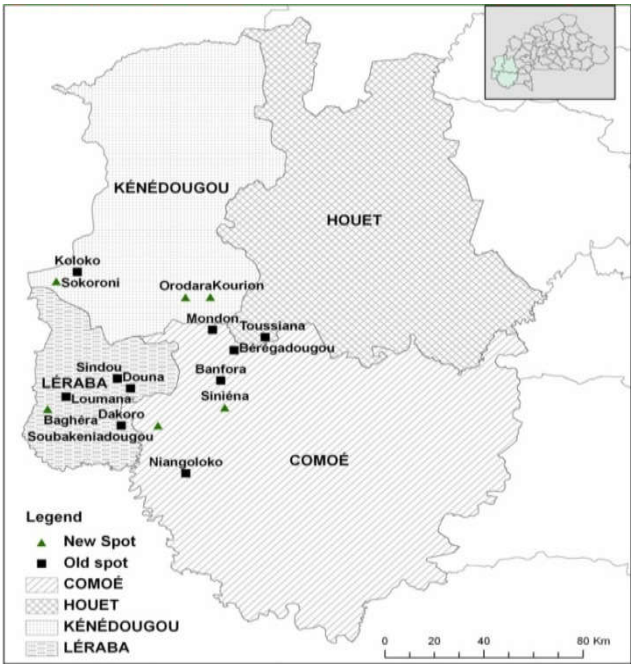

Figure 1 Localization of the various 'hot spots' for *Rastrococcus invadens* included in the study

Table 1 Number of orchards surveyed by locality, type of orchard and inventory period of host plants of *Rastrococcus invadens* in western Burkina Faso

Sites		Number of orchards	Type of orchards (period of survey)
Provinces	**Localities**		
Houet	Toussiana	1	AO (DS ; RS)
	Banfora	2	AO (DS)
	Bérégadougou	2	AO (DS ; RS)
	Mondon	1	AO (DS)
Comoé	Niangoloko	2	AO (DS) ; FO (DS)
	Siniéna	1	AO (DS)
	Koloko	1	AO (DS)
	Kourion	1	FO (DS ; RS)
Kénédougou	Orodara	2	AO (DS ; RS)
	Sokoroni	1	AO (DS)
	Dakoro	1	
	Douna	1	
	Loumana	1	
	Sindou	1	
Léraba	Baghéra	1	AO (DS)
	Soubakeniadougou	1	
Total		20	

AO: Agglomeration Orchard; FO: Field Orchard; DS: Dry Season; RS: Rainy Season

Inventory of host plants

Each orchard was surveyed on a radius of 200 m to identify plants infested by *R. invadens*. For this purpose, direct observations were made on the leaves, inflorescences and fruits of the plants along the diagonal of the orchard. All the infested plants were identified in situ with technical support of the Provincial Directorates of Environment by using two identification handbooks from Arbonnier (2000) and Bärtels (1994). The level of infestation was then assessed by counting the number of mealybugs (all stages inclusive) on 20 leaves randomly collected from trees, from tall shrubs and from shrubs. As to tall grass and weeds, the assessment was done on respectively 2 leaves and 5 legs. Some photos were also taken during the observations.

Entry and Statistical analysis of data

Data were entered on an Excel sheet of the Microsoft 2010 software and organized by identified host plants. The values that were entered were divided by the number of leaves or stems collected in order to get the level of infestation of each plant by using the scale used by Akintola and Ande (2009). The scores of the scale were: ≤5 mealybugs/leave (minor infestation), ≥ 10 mealybugs/leave (medium infestation), > 25 mealybugs/leave (severe infestation). The plants were then classified into several categories proportionally represented. There were food crops, fruit crops, ornamental plants, timber trees, vegetables, weeds and wild plants.

RESULTS

Specific diversity of host plants of Rastrococcus invadens

Table 2 presents the host plants of the mango mealybug that were tallied in the dry season and in the rainy season. On the whole of the prospected orchards, 40 plant species belonging to 24 families were infested by *R. invadens*. This range included food crops, fruit trees, ornamental plants, vegetables, weeds, wild plants and timber species. The largest number of host plants (5) belonged to the family of Rutaceae, followed by that of Anonaceae (3) and lastly by Moraceae (3). Other families were represented by 1 or 2 plant species. We observed all the three levels of infestation: minor, medium and severe. Thus, 27 plants have showed a minor level infestation.

Table 2 Host plants of the mango mealybug, *Rastrococcus invadens* on all sites visited in Western Burkina Faso

Host plants				
Family (Number of species)	**Species (category)**	**Common name**	**Growth stage**	**Level of infestation (*)**
Amaranthaceae (2)	*Amaranthus graecizans* (Ve)	Amaranth	Grass	*
	Amaranthus sp.(We)			
Annonaceae (3)	*Annona muricata* (Fr)	Sour sop	Tall shrub	*
	A. squamosa (Fr)	Sugar apple	Tall shrub	*
	A. senegalensis (Wi)	Wild sugar apple	Shrub	*
Apocynaceae (2)	*Saba senegalensis* (Wi)	Wild liana	Shrub	**
	Catharanthus roseus (Or)	----	Grass	*
Arecaceae (2)	*Borassus akeassii* (Fr)	Palmira	Tall grass	*
	Elaeis guineensis (Ve)	Palm oil tree		
Asteraceae (1)	*Acanthospermum hispidum* (We)	-----	Grass	*
Bombacaceae (1)	*Ceiba pentandra* (Wi)	Silk cotton tree	Tall shrub	*
Combretaceae (1)	*Terminalia latifolia* (Wi)	-----	Shrub	*
Convolvulaceae (2)	*Ipomoea batatas* (Ve)	Sweet potato	Grass	*
	Ipomoea sp. (We)	-----		
Euphorbiaceae (2)	*Jatropha curcas* (Or)	Physic nut tree	Tall shrub	
	Ricinus communis (Wi)	Castor oil plant	Shrub	*
Fabaceae (1)	*Piliostigma thonningii* (Wi)	-----	Shrub	*
Lamiaceae (1)	*Vitex doniana* (Wi)	-----	Tree	***
Lauraceae (1)	*Persea americana* (Fr)	Avocado tree	Shrub	*
Table continuation				
Malvaceae (2)	*Sida acuta* (We)	Sida	Grass	* ; **
	S. rhombifolia (We)			*
Meliaceae (2)	*Khaya senegalensis* (Or)	African mahogany	Shrub ; Tree	*** ;*
	Trichilia emetica (Wi)	-----	Shrub	*
Moraceae (3)	*Ficus polyta* (Or)	Fig trees	Tall shrub, Tree	**
	F. sur (Wi)		Shrub ; Tree	**
	Ficus sp. (Wi)		Shrub	*
Musaceae (1)	*Musa sapientum* (Fr)	Banana tree	Tall grass	* ; ***
Myrtaceae (1)	*Psidium guayava* (Fr)	Guava tree	Tall shrub	* ; **
Passifloraceae (1)	*Passiflora sp.* (We)	-----	Grass	***
Poaceae (2)	*Cymbopogon citratus* (We)	Lemon grass	Grass	*
	Zea mays (Fo)	Maize		**
Rutaceae (5)	*Citrus aurantifolia* (Fr)	Citrus fruits	Tall Shrub	*
	C. limon (Fr)			* ; ** ; ***
	C. tangelo (Fr)			* ;***
	C. reticulata (Fr)			*
	C. sinensis (Fr)			* ; **
Sapindaceae (1)	*Blighia sapida* (Fr)	Ackee	Tall shrub	*
Sapotaceae (1)	*Vitellaria paradoxa* (W)	Shea tree	Shrub ; Tree	*** ; *
Solanaceae (1)	*Nicotiana sp.* (We)	-----	Grass	*
Verbenaceae (1)	*Tectona grandis* (Ti)	Teak tree	Tall shrub	***

Fo: Food crop, Fr: Fruit crop, Or: Ornamental Plant, Ti: Timber species, Ve: Vegetable, We**:** Weed, Wi: Wild plant
(*) Level of infestation: *minor infestation, **medium infestation, *** severe infestation

The highest infestation level was observed on 8 plants. This included *Vitex doniana*, *Khaya senegalensis*, *Musa sapientum*, *Passiflora sp.*, *Vitellaria paradoxa*, *Citrus limon*, *C. tangelo* and *Tectona grandis*. Some plants exhibited varied infestations according to locations. This was the case with *C. limon*, *C. tangelo*, *C. sinensis*, *M. sapientum*, *Psidium guayava* and *Sida acuta*.

Photo 1 Colonies of *Rastrococcus invadens* on *Khaya senegalensis* leaves

Photo 2 Colonies of *Rastrococcus invadens* on *Vitellaria paradoxa* leaves

For some host plants, the level of infestation varied according to the growth stage. This included *K. senegalensis* and *V. paradoxa*. The photos show the attack of *Rastrococcus invadens* on the leaves of *Khaya senegalensis* (Photo 1), *Vitellaria paradoxa* (Photo 2), *Citrus sinensis* (Photo 3), *Tectona grandis* (Photo 4), *Psidium guayava* (Photo 5) and

Zea mays (Photo 6). The colonies of the insect were observed both on the lower and upper sides of the leaves through the main and secondary veins. They present a whitish appearance.

Photo 3 Colonies of *Rastrococcus invadens* on *Citrus sinensis* leaves

Photo 4 Colonies of *Rastrococcus invadens* on *Tectona grandis* leaves

Photo 5 Colonies of *Rastrococcus invadens* on *Psidium guayava* leaves

Photo 6 Colonies of *Rastrococcus invadens* on *Zea mays* leaves

Relative importance of host plants of Rastrococcus invadens

For all orchards surveyed, the range of host plants was composed at 30% (12) of fruit crops, 27.5% (11) of wild plants and 20% (8) of weeds. Ornamental plants and vegetables respectively represented 10% and 7.5% of identified species. Grains and timber species each accounted for 2.5%.

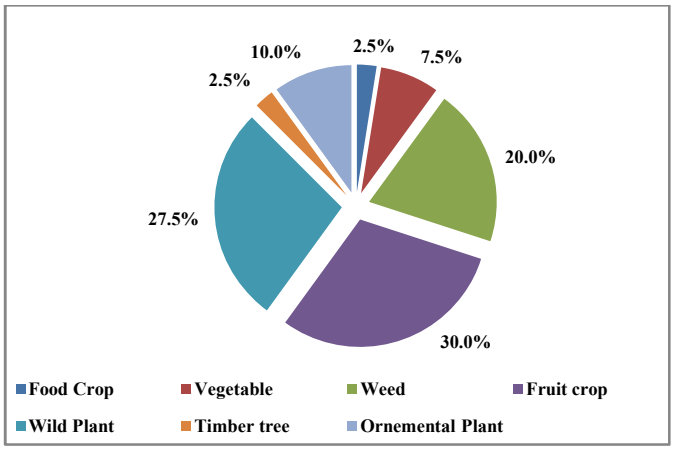

Figure 2 Proportion of host plants of the mango mealybug, *Rastrococcus invadens* in Western Burkina Faso.

DISCUSSION

Besides the mango tree (*Mangifera indica*), we registered 40 plant species distributed into 24 families that were attacked by the scale insect within its distribution area in Western Burkina Faso. The results showed a variation of infestation level between host plants. This could be probably due to host preference of insect. The results revealed that following host plants were more infested and could be preferred host of the insect. There were *Vitex doniana*, *Khaya senegalensis*, *Musa sapientum*, *Passiflora sp.*, *Vitellaria paradoxa*, *Citrus limon*, *C. tangelo* and *Tectona grandis*. Some of plant species identified in this study are already listed in the index of the 44 host plants reported in Togo and in Benin by Agounké *et al.* (1988). Like in this study, these authors noted a variation of infestation level for most of the plants that were indexed in these two countries. Their work also presented plant species that were respectively inflicted in Benin by the mealybug and not inflicted in Togo and vice versa. Besides, they listed papaya tree and neem, slightly infested, among the host plants of the insect pest. These two plant species did not present any infliction from the mealybug in the course of our study despite their presence in the severely infested mango orchards. The infestation level they exhibited classifies them as occasional hosts and they may henceforth not be infested in some agro-ecological areas such as ours. This phenomenon could also be related to the presence of active biological substances which impede the development of the insect on these plants. The work of Ande and Olowojulu (1999) evidenced the insect repellent effect of different parts (leaves, bark and fruits) of neem against the mango mealybug. Neem presented the same level of infestation in Dakar city where 13 species of host plants were indexed by Han *et al.* (2007). Contrary to our findings and those reported in Togo, Benin, Brazzaville Congo and Gabon (Agounké *et al.*, 1988; Biassangama *et al.*, 1991; Boussienguet and Mouloungou, 1993), guava tree does not ensure the maintenance of mealybug in the South-Guinean savannah of Nigeria (Akintola et Ande, 2009). Variation of infestation level that was observed between tall shrubs and trees of *K. senegalensis* and *V. paradoxa* could be linked to the

physico-chemical characteristics presented by each growth stage of these species. The leaves of tall shrubs that are usually young would be more supportive to the development of the insect pest. The relatively higher proportion of fruit crops, compared to the other host plants would be probably related to the diversity of fruit trees in our study zone which is a fruit production area at its best. Among these fruit trees, citrus are frequently seen in mango orchards or in their surrounding areas; this could explain their large number in the midst of fruit crops. The floristic diversity (weeds and wild species) in the prospected orchards could explain the large number of that category of plants that are inflicted by the mealybug. But most of these plants exhibited minor levels of infestation. The findings of this study are vital in term of the management of *R. invadens* using Integrated Pest Management (IPM) practices. Fruit crops and wild plants found to be predominant belonging host plants. The control of the pest on this category plants alone will not be suitable because of the presence of weed plants which are as important in the orchards during rainy season. It is therefore necessary to take all categories host plants during the implementation of control strategies. Out of the 40 host plants indexed in the course of our study, 25 are newly appearing in the index in West Africa and worldwide.

CONCLUSION

This study that was carried out in Western Burkina Faso revealed a wide range of plants inflicted by the mango mealybug. A total of 40 host plants distributed in 24 families were indexed in the dry and the rainy seasons. These plants were mostly dominated by fruit crops, wild species and weeds. We registered 25 new plant species listed in the index of host plants of the scale bug in Africa and worldwide. The diversity of these plants fosters the propagation of the insect pest in time and space. Usually found near infested mango trees, it is important to take them into account in promoting control strategies. This present study also showed that important local fruit producing species are inflicted by scale bugs. These include Shea tree and wild lianas which are non-timber forest products that are substantial for the rural populations.

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