



Coniesta ignefusalis:

a Handbook of Information

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Abstract

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A comprehensive review of the biology and management of *Coniesta ignefusalis* (Hampson), the millet stem borer, is presented in this two-part bulletin. The information is categorized under pest status and crop loss assessment, taxonomic descriptions, pest biology and ecology. Pest management practices including cultural, plant resistance, biological, legislative, chemical, and integrated methods are discussed. Part 2 contains an annotated bibliography of nearly 150 references published between 1950 and 1994.

Résumé

Coniesta ignefusalis (Hampson), le foreur du mil: un manuel d'informations. La recherche sur la biologie de *Coniesta ignefusalis*, le foreur du mil, ainsi que sur les méthodes de lutte contre l'insecte sont passées en revue dans cette publication à deux parties. L'information est regroupée sous diverses rubriques: importance du ravageur et estimation de la perte des cultures, descriptions taxonomiques, biologie et écologie de l'insecte. La gammes des méthodes de lutte culturale, biologique, législative, chimique et intégrées ainsi que la résistance des plantes y est également exposée. La deuxième partie du document comprend une bibliographie annotée de près de 150 références publiées entre 1950 et 1994.

Resumen

Coniesta ignefusalis (Hampson), el barrenador del mijo: manual de información. Esta publicación dividida en dos partes presenta un estudio global de la biología y lucha contra *Coniesta ignefusalis* (Hampson), el barrenador del mijo. La información esta organizada bajo diferentes aspectos: estatus del insecto y estimación de la pérdidas en los cultivos, descripción taxonomica, biología y ecología del insecto. Las practicas de manejo contra la plaga, incluyen una amplia gama de opciones—culturales, resistencia de las plantas, métodos biológicos, químicos, legislativos así como el manejo integrado. La segunda parte del documento contiene una bibliografía detallada de mas de 150 referencias publicadas entre 1950 y 1994.

Cover: *Coniesta ignefusalis*, full-grown larva and frass in tunneled pearl millet stem; inset, adult female.

Coniesta ignefusalis (Hampson) the Millet Stem Borer

a Handbook of Information

O Youm, K M Harris, and K F Nwanze

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Preface

At the International Workshop on Sorghum Stem Borers, held at the ICRISAT Asia Center, Patancheru, India in Nov 1987, it was agreed that published and unpublished information on the biology, ecology, physiology, and behavior of the main stem borer species should be critically reviewed to provide a basis for further work. The first of these handbooks (Harris and Nwanze 1992) is a comprehensive review of the biology and management of the African maize stalk borer, *Busseola fusca* (Fuller), based on a bibliography of nearly 400 references published between 1900 and 1990.

At the Regional Pearl Millet Workshop, held at ICRISAT Sahelian Center (ISC), Sadoré, Niger, in 1990, and also at a meeting of the West and Central African Millet Research Network (WCAMRN), held at ISC in 1991, it was recommended that support to National Agricultural Research Services in the region could be provided by compiling information handbooks on key pearl millet pests. This handbook on *Coniesta ignefusalis* (Hampson), which is a major pest in Africa, has therefore been prepared to help decision-making in an integrated pest management approach (IPM) and to provide a reference source for current and future research on the pest. Part I is a review of information available on the biology, ecology, and management of *C. ignefusalis* and Part II is a comprehensive annotated bibliography, prepared by ICRISAT's Library and Documentation Services, Information Exchange and Management Program. This is followed by a directory of scientists and institutions that are studying this pest.

Acknowledgments

We gratefully acknowledge the literature search made by several institutes: Département de formation en protection de végétaux (DFPV), Centre régional de formation et d'application en agrométéorologie et hydrologie opérationnelle (AGRHYMET), an institute of the Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel (CILSS), and Institut sénégalais de recherches agricoles (ISRA). We also thank the authors of current and past publications who have provided reprints. Our colleagues in ICRISAT (Asia and Sahelian Centers) and CAB International actively contributed to the preparation of the handbook.

We are especially grateful to S Prasannalakshmi, ICRISAT Library and Documentation Services, for finalizing Part 2, the annotated bibliography that was compiled with initial support from S Dutta and the Alliance française of Hyderabad.

Descriptive drawings of *Coniesta ignefusalis* stages (Fig. 1) are from Harris (1962) (copyright, CAB International). Photographs of *Coniesta ignefusalis* egg masses (Fig. 3), larva (Fig. 4), and pupa (Fig. 6) (copyright, M Mathews). Photograph of a diapausing larva of *Coniesta ignefusalis* in stem (Fig. 5) (copyright, K M Harris). Additional illustrations (Figs. 2, 8, 9, 10a, 10b, 10c, and 11) were provided by O Youm.

Part 1

Review of Bioecology and Management

O Youm, K M Harris, and K F Nwanze

Introduction

The millet stem borer, *Coniesta ignefusalis* (Hampson), was first named and described by Hampson (1919) in the genus *Diatraea*. Since then, although its status as a good species has never been in doubt, its correct generic placing has still not been determined. Taxonomists have assigned it to such different genera as *Haimbachia*, *Eoreuma*, and *Donacoscaptis*. It was most recently assigned to *Acigona*, but as the genus is now known to be a noctuid and not a pyralid, it has been recommended that the species should remain in *Coniesta* until a thorough taxonomic revision can be undertaken (Agnew 1987).

Coniesta ignefusalis is well known as a persistent and often damaging pest of pearl millet, *Pennisetum glaucum* (L.) R. Brown, especially in the Sahelian and subSahelian zones of West Africa. It is not known to be important on other cereals.

Pest Status and Crop Loss Assessment

During feeding and development, *C. ignefusalis* larvae cause two types of damage. Early-sown millet is attacked by first-generation larvae which damage young plants and cause dead-hearts. Seedlings of late-sown millet are exposed to higher populations of second or third-generation larvae which produce extensive tunnels in the stems that may kill the plant. On older plants, stem tunneling may cause lodging and panicle chaffiness due to disruption of the plant vascular system which prevents grain formation (Harris 1962; NDoye 1979; Nwanze 1989; Ajayi and Labe 1990).

Very few rigorous crop loss assessments are available from studies in farmers' fields. Farm surveys usually reveal infestation levels, but information on actual crop losses are derived from research station experiments. Surveys in Nigeria, Niger, and Burkina Faso recorded borer infestation in all farmers' fields sampled; stem damage ranged from 56–100% in Nigeria, 24–76% in Niger, and 23–89% in Burkina Faso (Nwanze 1989). The highest damage was recorded in the wetter Sudanian zones of Burkina Faso.

Harris (1962) projected a 15% loss in Kano, Nigeria, where infestation was high, otherwise losses were usually about 5%. In Niger, moderate

levels of enhanced infestation on six millet cultivars under experimental conditions reduced yield by 0.5–45% (Lukefahr 1988). Nwanze (1989) reported that low levels of borer attack resulted in a slight increase in yield of the unprotected treatments over the control. This was attributed to tillering response to low borer infestation. Later studies by Lukefahr (1989b) with varying levels of carbofuran revealed that grain yield increased with decreasing larval populations. However, he thought the increase in yield could have been due to growth stimulation induced by increased carbofuran applications.

Attempts to determine measurement parameters which relate stem damage to loss in grain yield have produced variable results. Harris (1962) obtained conflicting results while comparing yield capacities of individual bored and unbored millet stems. Bored stems yielded less than unbored stems in three cases and more in two. The latter was attributed to the association of borer attack with better growing plants. Ajayi and Labe (1990) found good correlations between the number of borer holes, percentage of internodes with borer holes, and total tunnel length. Lukefahr (1990) converted the number of exit holes into larval populations and reported that it required more than 10 larvae per stem before any realistic reductions in grain weight occurred. Densities of 17–24 larvae per stem reduced grain yield by 14%.

Descriptions

Hampson (1919) published a brief formal description of the female moths. Illustrated descriptions of all stages (Fig. 1), based on specimens collected in northern Nigeria were published by Harris (1962). Betbeder-Matibet (1987) produced a data sheet with color photographs of all stages and of bored stems.

Adults

Adults are nocturnal; during the day, they remain well camouflaged on leaves, stems, and trash, often resting head downward on the plant. They are typical pyralid moths with golden-brown forewings and silky-white hind wings and at rest, the forewings are held over the hind wings and abdomen in a tent-like position (Fig. 2). Wing length

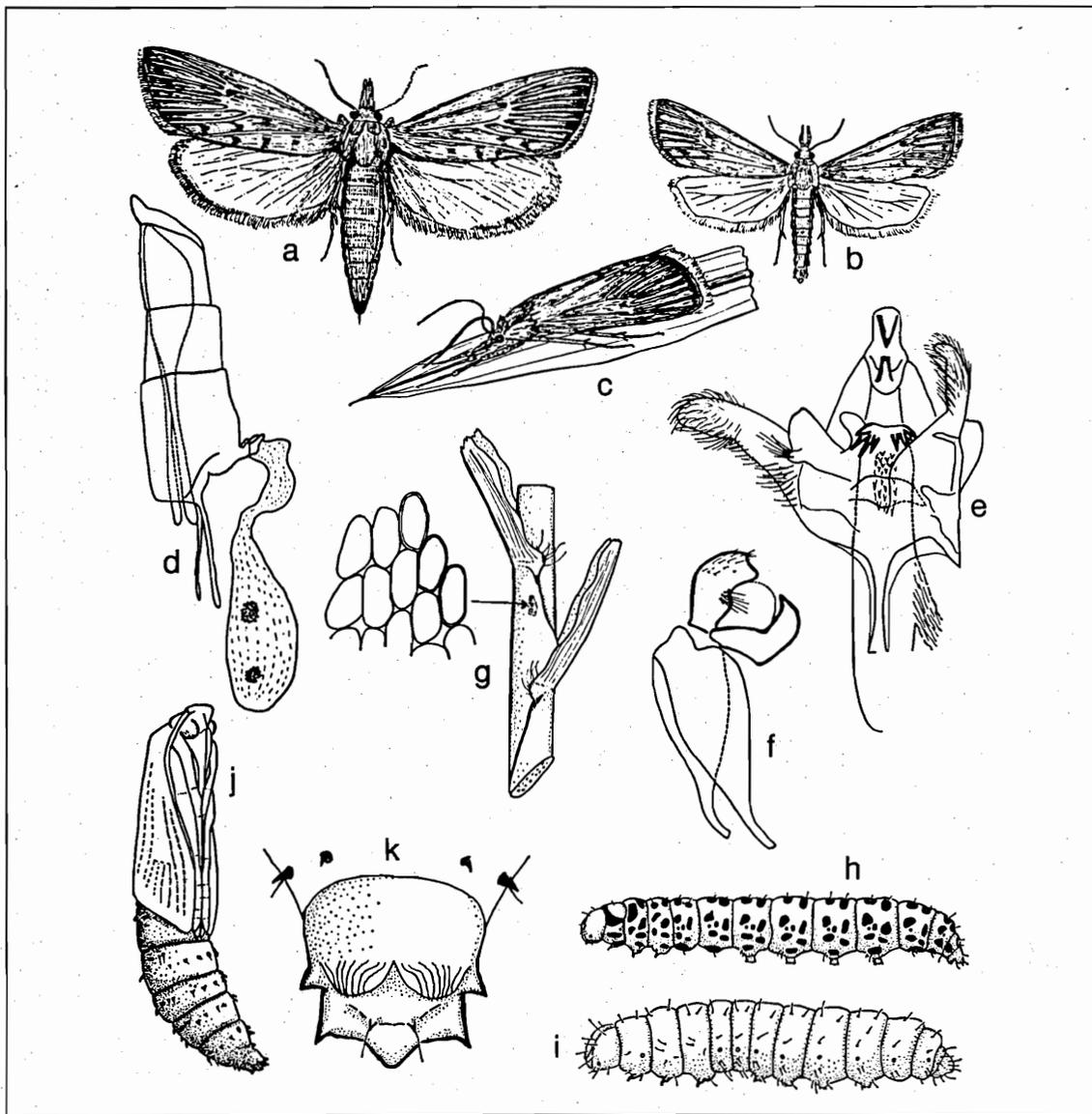


Figure 1. *Coniesta ignefusalis*: a) female; b) male; c) female at rest; d) female genitalia, lateral view; e) male genitalia, ventral view; f) tegumen, lateral view; g) eggs; h) non diapausing larva; i) diapausing larva; j) pupa; k) pupal cremaster, ventral view.

ranges from 8 to 15 mm and females are generally larger than males. They have a blade-like chitinized ovipositor which is extended from the tip of the abdomen during oviposition.

Adult moths reared from pearl millet and matching this description are most likely to be *C. ignefusalis*, especially in West Africa. In southern and eastern Africa, however, pearl millet plants are also attacked by *Chilo partellus* (Swinhoe),

which is superficially similar to *C. ignefusalis*. Specimens should be referred to a specialist if there is any doubt about their identity.

Eggs

Eggs are about 1-mm long and are laid in batches of 20–25 between leaf sheaths and stems (Fig. 3). They are yellowish-white and elliptical and are



Figure 2. Adult *Coniesta ignefusalis* female on pearl millet leaf.

partially flattened by the pressure of growing stems against the leaf sheaths.

Larvae

Larvae grow to a length of about 20 mm and have a prominent, reddish-brown head. During the growing season, the white body of active larvae is conspicuously marked with black spots (Fig. 4). During the dry season, they enter into diapause and lose these black markings (Fig. 5). The pyralid larvae are easily distinguished from those of the noctuid stem borer by the circular series of crotchets on the ventral abdominal prolegs (Fig. 1h).



Figure 3. *Coniesta ignefusalis* egg mass under a leaf sheath.

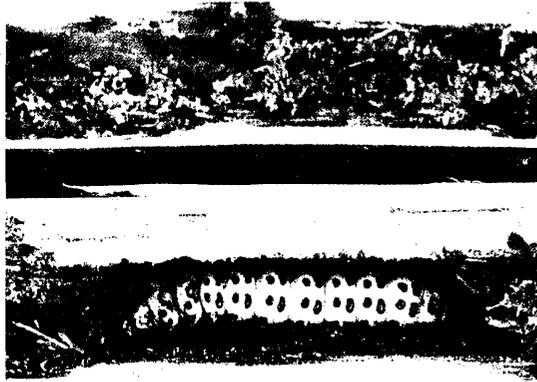


Figure 4. *Coniesta ignefusalis* full-grown larva and frass in tunneled pearl millet stem.



Figure 5. *Coniesta ignefusalis* diapausing larva in tunneled stem.

Pupae

Pupae are up to 15 mm long, yellowish to reddish brown and with thorn-like spikes on the abdominal segments (Fig. 6).

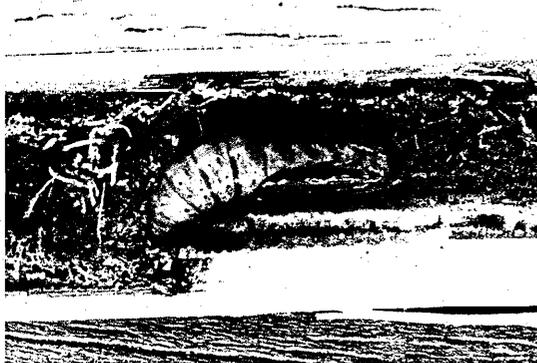


Figure 6. *Coniesta ignefusalis* pupa in larval tunnel in pearl millet stem.

Biology and Ecology

Life Cycle

The life history of the millet stem borer was described by Harris (1962) (Fig. 1a-j) and by Bako (1977). Adults are active mostly during scotophase, but remain on the lower leaf surface or along stems, with head turned towards the ground during the day. In Nigeria, the sex ratio

from light traps or by rearing adults from field-collected eggs, larvae, and pupae showed significantly more females than males (Harris 1962). In Niger, a sex ratio of 1:1 was reported based on a sample of 1087 pupae, suggesting that the ratio imbalance from light trap catches could be due to differential responses of males and females to light (ICRISAT 1988). Mating in the laboratory occurs late during the night of adult emergence or early the following night. Oviposition begins the

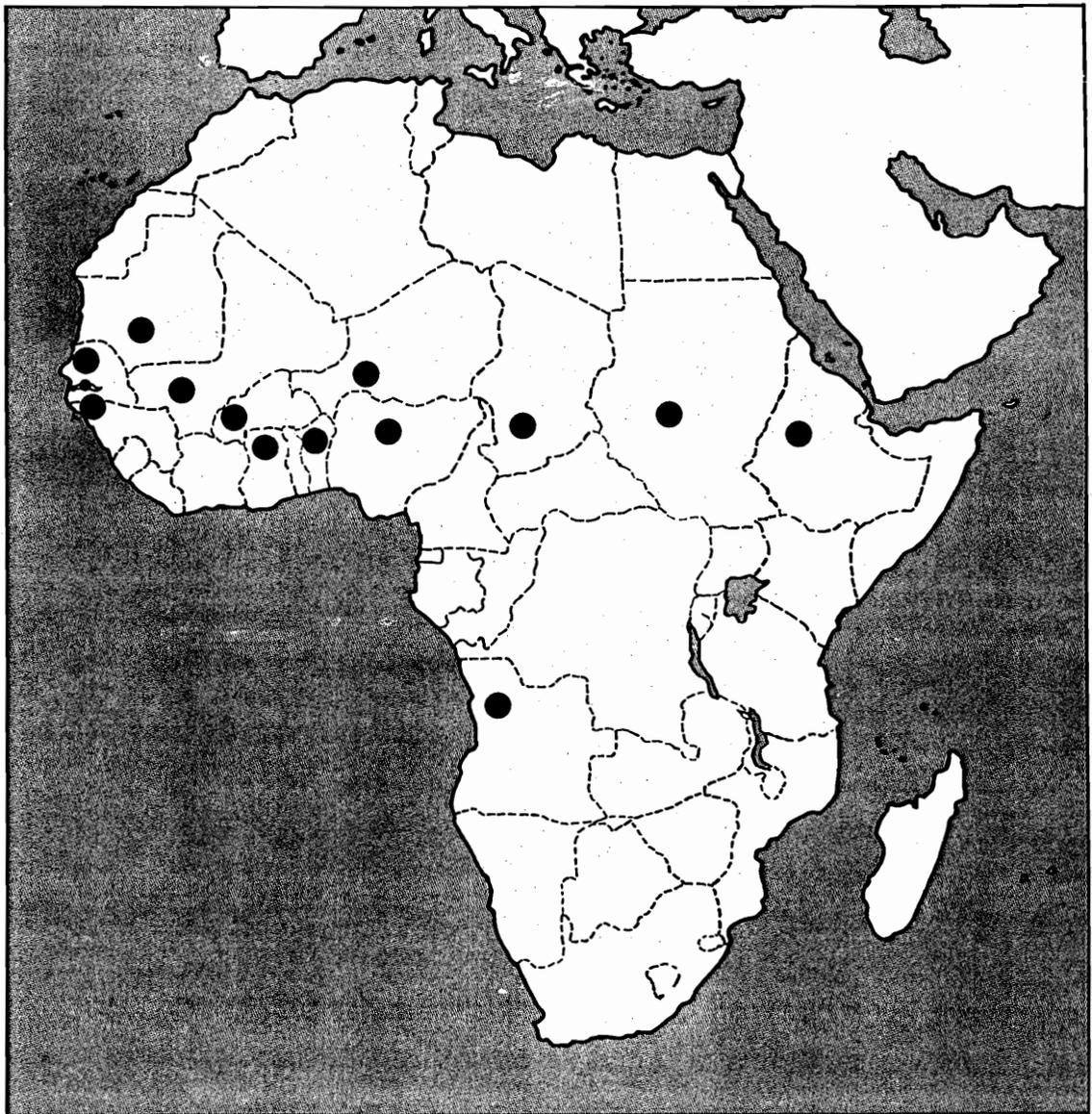


Figure 7. Distribution of *Coniesta ignefusalis* in Africa.

first night after mating and peaks on the third night after emergence. It can continue through the sixth night after mating. In the field, adult females place their eggs in batches, averaging 20 to 50 eggs between the leaf sheath and the stem (Harris 1962), or on lower leaf blades (Gahukar 1984a, b). Youm (1990) and Youm and Gilstrap (1994) reported that *C. ignefusalis* oviposition is mostly associated with leaf sheath and rarely occurs on leaves. Each female may lay over 200 eggs in total. Newly deposited eggs are creamy white to yellow, turning dark after 8 to 11 days, and hatch 24 h after darkening. Two or three generations occur during each millet-growing season.

Host Plants

The main host plant is pearl millet; however, sorghum [*Sorghum bicolor* (L.) Moench] may also be attacked, especially when it is intercropped with millet. Maize [*Zea mays* L.] and sugarcane [*Saccharum officinarum* L.] have been recorded as host plants. Some grasses, especially *Pennisetum purpureum* Schumacher, *Panicum maximum* Jacquin and *Andropogon gayanus* Kunth have also been recorded as hosts. Youm (1990) reported 14a different host plants, including some nongraminaceous plants that harbor diapausing larvae during the onset of dry season in Niger. It is possible that other undescribed species of *Coniesta* occur on grasses that are not closely related to pearl millet and the host range of *C. ignefusalis* will only be clearly defined when adequate taxonomic studies can be commissioned.

Geographical Distribution

Coniesta ignefusalis is restricted to mainland Africa, south of the Sahara and has been most frequently recorded in West Africa (Senegal, Mali, Gambia, Guinea Bissau, Benin, Burkina Faso, Chad, Mauritania, Ghana, Niger, and Nigeria). It has also been recorded in Sudan, Ethiopia, and Angola (Fig. 7) and is probably more widely distributed in tropical Africa than published records indicate. In Nigeria, it occurs at altitudes up to about 1000 m.

Larval Development and Behavior

Hatched larvae remain clustered for approximately 24 h, then tunnel into the leaf sheaths



Figure 8. Deadheart caused by *Coniesta ignefusalis* larvae on pearl millet.

and eventually enter the stalk. During feeding and development, the stem borer causes different types of damage depending on the stage of millet growth and the generation of infesting larvae. First-generation larvae cause deadhearts and a consequent loss of crop stand (Fig. 8). Second-generation larvae cause lodging, disrupt the plant vascular system (Fig. 4), and prevent or limit grain formation (Fig. 9). Larvae can migrate between plants, moving a maximum of 1.2 m in the insectary and 1.8 m in the field (Harris 1962). Larval survival during the growing season is high probably because larvae enter leaf sheaths or stems within 24 h after hatching. During the wet season, larvae complete development in approximately 30 to 40 days (mean 34 days). There are usually six, but sometimes seven instars. Male pupae develop in 7–12 days (9.3 average), and female 7–13 days (9.7 average). Pupation



Figure 9. Lodging of windprone stems due to damage by *Coniesta ignefusalis*.

occurs in the larval tunnel and adults emerge 7–13 days after pupation.

Larval Diapause

In the last generation, larvae cease feeding during the dry season, line their tunnels with silk, and lose all integumental pigment. They become pale yellow to creamy white (Fig. 5) and enter into facultative diapause; the nondiapausing larvae continue to retain their black spots. Diapause usually continues for 6–7 months, but may continue up to more than a year (Harris 1962).

Field observations also show that *C. ignefusalis* pupation occurs when both optimum photoperiod and contact moisture are reached (ICRISAT 1988). *Coniesta ignefusalis* also undergoes a state described as “aseasonal quiescence” which is a state of arrested development linked to adverse environmental conditions (ICRISAT 1988).

Carry-over Populations

Postharvest crop residues are considered to be the main source of diapausing larvae (Fig. 10). In Nigeria, Harris (1962) reported that early stem borer attack is noticeably more severe on crops grown in or near villages than those far from villages. It is generally impractical to destroy crop residue as many farmers use stalks for roofing, fencing, traditional granaries (Fig. 10), shop kiosks, and animal bedding (Harris 1962).

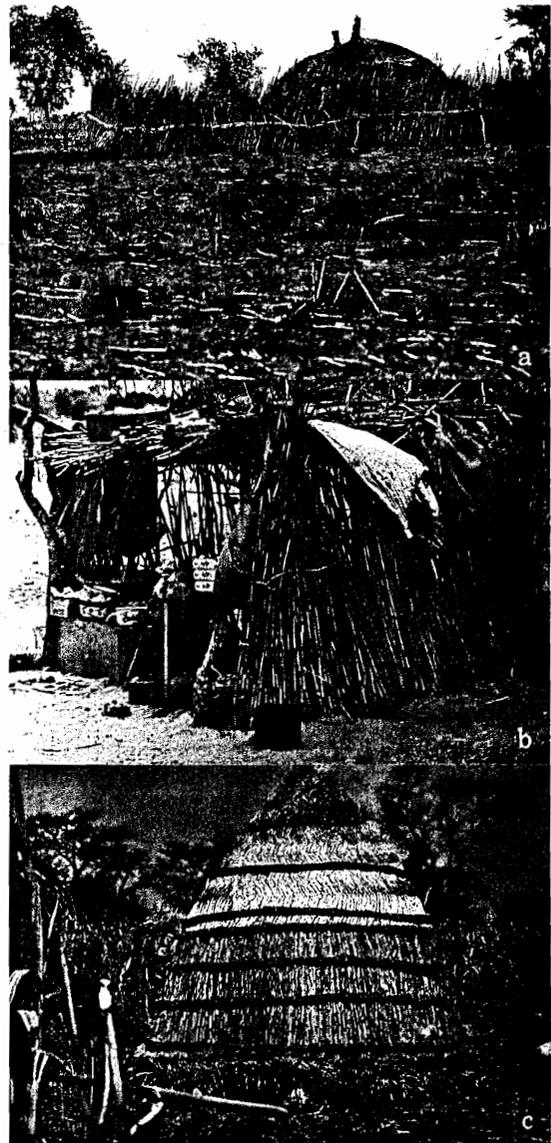


Figure 10. Source of initial stem borer infestation of millet seedlings: (a) crop residue and pearl millet stems containing diapausing *Coniesta ignefusalis* larvae used for fencing; (b) roofing; and (c) traditional granaries.

Adult Emergence, Mating, and Dispersal

During the dry season, larvae remain in diapause until the onset of the next season rains and then pupate. Emerging adults infest the new millet plants. Nothing is known about adult movements

and migratory habits. However, like most pyralids, the millet stem borer is unlikely to be a migratory pest. Mating is mediated by the female sex pheromone which attracts males. *Coniesta ignefusalis* sex pheromone consists of a three-component blend: (Z)-7-dodecen-1-ol, (Z)-5-decen-1-ol, and (Z)-7-dodecen-1-al (Youm et al. 1993a). Youm et al. (1993b) reported that female attractiveness was affected by age: males were more attracted to 1-day old females than 4-day old ones probably because older females produce less pheromone. However, this needs to be further investigated.

Oviposition

Caging several substrates with the millet stem borer in laboratory choice tests, Youm (1990) reported that oviposition mostly occurred on leaf sheaths of green millet stems. Oviposition rarely occurred on dry or green leaves or on dry stems (Youm and Gilstrap 1994).

Parasitoids, Predators, and Pathogens

Various insect parasitoids of *C. ignefusalis* have been recorded, mainly by Risbec (1950, 1960), Harris (1962), Bako (1977), NDoye (1980), Gahukar (1981), NDoye et al. (1984), Ajayi (1985), Markham (1985), NDoye and Gahukar (1987), Youm (1990), Youm and Gilstrap (1993a, b) (Table 1). Their relative importance in reducing *C. ignefusalis* populations has not been extensively assessed. Mohyuddin and Greathead (1970) published an annotated review of the parasitoids and predators of the main stem borers of graminaceous crops in eastern Africa. In a survey in Niger and Burkina Faso, Markham (1985) reported that *Syzeuctus* sp was the main larval parasite of *C. ignefusalis* and was by far the most abundant, occurring in 17 out of 32 sites. Other species, *E. rufa* and *G. procerae* (Risbec) were occasionally present. Pupal parasitism was much lower. Youm and Gilstrap (1993a, b) assessed parasitism of *C. ignefusalis* in millet monocropping and concluded that parasitoids were not effective against the millet stem borer except for an egg parasite *Telenomus busseolae* Gahan (*Hymenoptera: Scelionidae*) which has a parasitism of 15.2%. Using exclusion techniques, Youm (1990) assessed the effectiveness of natural enemies of the millet stem borer and concluded that para-

sitoids did not adequately control *C. ignefusalis*. He reported that *Orius* sp and an ant species *Monomorium* sp attacked *C. ignefusalis* and that predators are probably largely responsible for killing the first instars. A Dutch-funded international collaborative project (DGIS) on parasitoids of stem borers of cereal crops in western and eastern Africa is currently undertaking taxonomic research aimed at validating all records.

The only published record of a pathogen from *C. ignefusalis* is of *Metarhizium anisopliae* Sorokin from a larva in Nigeria (Harris 1962). Published records of predators include two sphecid wasps, *Dasyproctus westermanni* Dahl. and *D. immitis* Saussure, also in Nigeria (Ajayi 1990), but it is probable that these species were simply using stem borer tunnels as nesting sites.

Population Dynamics

Infestations by *C. ignefusalis* can occur throughout the year if suitable crops or alternative host plants are available in the field. However, at most locations, two to three generations are produced. Three distinct generations develop during the crop season in the wetter Sudanian zone at Samaru, Nigeria (Harris 1962), while two generations have been recorded in the drier Sahelian zones of Niger and Burkina Faso (Nwanze 1989). Gahukar (1984b, 1990a) reported the occurrence of two to three generations in Senegal.

In Niger, the first-generation moths emerge from diapausing larvae after the onset of rains whose timing is often variable. A peak in moth population of the first generation occurs in July and of the second generation in September (Nwanze 1989). In the more southerly Sudanian zone of Nigeria, where the rains are earlier and longer, the first generation appears in March/April. Towards the end of the rains, larvae enter into diapause and survive in dry stems and stubbles until the following growing season.

The population of diapausing larvae in stems declines during the dry season from November to May and is drastically reduced between March and May when temperatures exceed 40°C. The size of the carry-over diapausing larval population at the end of the dry season, the time of onset of rains, and the total amount of rainfall largely determine the number of generations and population size (Nwanze 1989).

Table 1. Insect parasitoids of *Coniesta ignefusalis* in Africa¹.

Species	Remarks
HYMENOPTERA	
Ichneumonidae	
<i>Dentichasmias busseolae</i> Heinrich	Western, eastern, and southern Africa, mainly from pyralid stem borers (Mohyuddin and Greathead 1970)
<i>Syzeuctus senegalensis</i> Benoit	Niger (Youm 1990; Youm and Gilstrap 1993a, b), from larvae
Braconidae	
<i>Glyptapanteles africanus</i> (Cameron)	Mali (Walker 1994)
<i>Euwipio unifasciatus</i> (Brulle)	Nigeria (Harris 1962; Ajayi 1985; Youm and Gilstrap 1993a, b)
<i>Rhaconotus</i> sp	Niger (Youm 1990; Youm and Gilstrap 1993a, b) from larvae
<i>Tropobracon antennatus</i> (Granger)	Western, eastern, and central Africa (Polaszek, unpublished)
Chalcididae	
<i>Pilochalcis soudanensis</i> (Steffan) [= <i>Hyperchalcidia soudanensis</i> (Steffan)] [= <i>Invreia soudanensis</i> (Steffan)]	Western and eastern Africa on various stem borers, especially pyralids (Mohyuddin and Greathead 1970)
Eulophidae	
<i>Pediobius furvus</i> (Gahan)	Eastern and western Africa, widespread on various pyralid and noctuid stem borers but more abundant in drier areas (Mohyuddin and Greathead 1970)
<i>Tetrastichus atriclavus</i> Waterston	Eastern and western Africa, from various stem borers (Mohyuddin and Greathead 1970)
Scelionidae	
<i>Telenomus busseolae</i> Gahan [= <i>Platyelenomus hylas</i> Nixon]	Widely distributed in Africa, Asia and southern Europe, mainly parasitizing eggs of noctuid stem borers (Polaszek and Kimani 1990)
Bethylidae	
<i>Goniozus indicus</i> Ashmead [= <i>Goniozus natalensis</i> Gordh] [= <i>Goniozus procerae</i> Risbec]	SubSaharan Africa, Mauritius, Madagascar, Bangladesh, India, and Pakistan (Polaszek, unpublished)
[Note: <i>Aphanogmus fijiensis</i> Ferriere, <i>Exoristobia dipterae</i> (Risbec), and <i>E. braconidis</i> Ferriere are hyperparasites, not primary parasitoids (Polaszek and Lasalle, personal communication)]	
DIPTERA	
Tachinidae	
<i>Descampsina sesamiae</i> Mesnil	Nigeria (Ajayi 1990)
<i>Sturmiopsis parasitica</i> (Curran)	Western and eastern Africa on pyralid and noctuid stem borers (Mohyuddin and Greathead 1970)
[Note: Records of the chloropid genera <i>Epimadiza</i> and <i>Polyodaspis</i> and of the phorid genus <i>Megaselia</i> as parasitoids of <i>Coniesta</i> are not accepted since species in those genera are most unlikely to be parasitoids]	
Acarina	
<i>Pyemotes ventricosus</i> (Newport)	Nigeria (Harris 1962), ectoparasite on diapause larvae

1. Only the most important and reliably identified species are listed.

Pest Management

Cultural Control

Crop residues and tillage

The importance of crop residues in carrying over diapausing larval populations from one growing season to the next has already been noted. Crop residues are generally not destroyed because many farmers use millet stems for fencing and building (Harris 1962), and to reduce wind erosion in dry and sandy areas (Ajayi 1990). Thus, approaches in cultural control of *C. ignefusalis* which are compatible with farmers' practices and adapted to Sahelian conditions should be encouraged. In addition, these methods should be compatible with soil conservation and erosion control schemes in the Sahelian region.

A review of field sanitation as a means for controlling stem borers is provided by Nwanze and Mueller (1989) and practices such as burning of stems were reported by Maiga (1984) and Guevremont (1983). Lukefahr et al. (1988) reported that crop residue management was a promising cultural control tactic. Different combinations of crop residue management have been evaluated to find out the most effective and compatible technique for an integrated approach to control the millet stem borer in the Sahelian conditions (Mamalo 1990). Cutting stems and laying them on the soil surface soon after harvest or incorporating stems 5 cm below the soil surface provides over 90% control of carry-over populations (Lukefahr et al. 1988). Similar findings have been reported by Youm et al. (1993) who stressed the possibility for implementing crop residues management to control the millet stem borer at the farmers' level. Bouchard et al. (1993), working at Bobo-Dioulasso, Burkina Faso, studied the effect of time of harvest of stems on the carry-over population of diapausing larvae. Results in 1988-89 show that harvesting the stems between 11-22 Nov reduced the carry-over population of diapausing larvae by 78-92% and in 1989-1990, harvesting stems between 3-27 Nov reduced the population by 76-88%. Harvesting by mid-November prevents many of the third-generation larvae from completing their development and entering into diapause.

Crop rotation

Crop rotation as a means of reducing stem borer incidence and damage has not been reported in the literature. Such an approach seems to be more appropriate for soilborne pests such as white grubs and is unlikely to be an effective control method for *C. ignefusalis*, as it would require extensive cultivation of a legume (groundnut, for example). But, this would be difficult to implement for two major reasons: 1) millet is grown in a very harsh environment; and 2) the area under millet cannot be reduced as it is used as a staple food crop.

Sowing dates

Using different sowing dates to control the stem borer has been evaluated (Vercambre 1978; Guevremont 1980; Ajayi 1985, 1990; Ajayi and Labe 1990; Youm 1990; Youm and Gilstrap 1993a, b). However, results vary according to season, location, and climatic conditions. Sowing dates are not usually uniform and are linked to rainfall variability and farmers' practices. Although late-sown millet is usually more attacked (Harris 1962), it is difficult for farmers to use uniform sowing dates.

Removal of deadhearts and volunteer crop plants

Harris (1962) and Nwanze and Mueller (1989) have suggested the removal of deadhearts to reduce borer infestation levels. Further evaluation of the technique and rate of adoption by farmers should result in large-scale recommendation to farmers. Socioeconomic studies on manual labor needed for removing deadhearts and volunteer crops and its cost to farmers should be conducted to measure the advantages and limitations of the technique.

Fertilizer management

Gahukar (1992) suggested that the effect of fertilizer application on insect abundance and plant damage should be taken into account in pest management strategies. A complete fertilizer dosage at 50-300 kg per hectare or urea at 50-200

kg per hectare applied to plots sown with two pearl millet cultivars (Souna and IBV 800) resulted in a significant increase in *C. ignefusalis* infestation and larval abundance. However, 50–200 kg ha⁻¹ of super phosphate reduced *C. ignefusalis* infestation. Lukefahr (1989b) reported an increase in *C. ignefusalis* larval numbers as the level of nitrogen fertilizer application increased. The larval population increased by 34.2% when the rate of nitrogen application increased from 45 kg ha⁻¹ (standard rate) to 90 kg ha⁻¹. He noticed that phosphorus had a greater impact than nitrogen in increasing larval population on millet and concluded that fertilizers should be carefully applied so as not to increase insect populations. Elemo and Ajayi (1989) reported that millet and sorghum grain yield, as well as stem borer infestation in an intercrop, were not significantly influenced by the rate and time of nitrogen application. However, they reported that in one of the study years, severe stem borer infestation and damage resulted in total crop failure. In Nigeria, Ajayi (1990) applied 0–150 kg N ha⁻¹ as compound and calcium ammonium nitrate fertilizer and found that stem borer damage on sole crop dauro millet (transplanted) increased with the rate of nitrogen applied.

Intercropping

Elemo and Ajayi (1989) reported that sole millet significantly outyielded millet intercropped with sorghum, although neither the rate nor the time of nitrogen application affected millet grain yield and parameters of stem borer damage in the mixture. Their findings were similar to those of Adesiyun (1983) where no clear difference was observed in the level of infestation by *C. ignefusalis* between sole and mixed crop millet. However, the effect of intercropping millet with noncereal, and therefore nonhost crops on stem borer damage to millet needs to be investigated (Ajayi 1990).

Host-Plant Resistance

Millet resistance to *C. ignefusalis* has been studied in Niger, Nigeria, Senegal, and other countries in the Sahelian region. The millet variety "Zongo" reportedly produces a sticky secretion in stem galleries of larvae, and thus offers some resistance by antibiosis (NDoye 1977). Nwanze (1985) reported that increased rates of tillering in

certain millet varieties is a tolerance mechanism for minimizing losses caused by stem borer. Ajayi (1985) suggested that hairiness of the leaves and leaf sheaths could explain differences in the levels of stem borer infestation of the three millet types (gero, dauro, maiwa) in Nigeria. Resistant millet varieties are not available. However, artificial infestation techniques using infested millet stems have been used by Lukefahr (1989a). The technique was improved at the ICRISAT Sahelian Center (ICRISAT Sahelian Center 1991). Lukefahr (1989a) has used stem borer exit holes as a measurable and repeatable technique for screening pearl millet varieties. The technique consists of placing vertically bundles of infested stems at regular intervals in plots sown with test varieties to evaluate resistance to millet stem borer. Preliminary studies have also shown that plants with trichomes received fewer eggs than trichomeless plants (ICRISAT Sahelian Center 1994). Oviposition nonpreference, and leaf sheath morphology and attachments should be considered in studies to identify resistance.

Biological Control

Biological control of *C. ignefusalis* by importing of natural enemies has not been attempted. As stem borers are chronic and serious pests in tropical graminaceous crops (Jepson 1954), and as yields are usually inadequate to justify the use of insecticides (Swaine 1957), biological control by predators and parasites and in combination with other pest management tactics seems promising to control the millet stem borer. Classical biological control by introduction and establishment of parasitoids of other pyralids (*Chilo*, *Diatraea* etc.) from other parts of the world may offer some opportunities but may prove difficult in the harsh climates where pearl millet is cultivated. Management of indigenous natural enemies by conservation and possibly through augmentations may also have some potential. Parasitism has been reported to be low and occurs late in the millet-growing season (Harris 1962; NDoye 1977, 1980; Nwanze 1985; Guevremont 1983).

Except for studies reported by Youm (1990), information on the impact of natural enemies in controlling the millet stem borer in West Africa is sparse (Markham 1985). Youm (1990) reported low parasitism of *C. ignefusalis* larvae on millet and that natural enemies were not effective in

controlling the borer. He also suggested that parasite ineffectiveness was possibly due in part to such biological attributes as poor searching capacity and long generation time. The short rainy-season cropping systems probably did not allow parasites enough time to build up and keep the borer in check. Habitat management should be explored as a means of maintaining and improving survival of natural enemies in the agroecosystem. As a final step, more effective short-generation stem borer parasites from other parts of the world could be introduced. Parasites should be collected from stem borers related to *C. ignefusalis* which attack graminaceous crops and other grasses. Research on the search for and management of effective natural enemies of *C. ignefusalis* should be encouraged.

Chemical Control

Dimethoate (Maiga and Issa 1988) and Furadan® (Maiga and Issa 1988; Ajayi 1990; Uvah and Ajayi 1989) were reported to be effective against millet stem borer; however, their use by small farmers is limited because of their costs (Maiga and Issa 1988). *Coniesta ignefusalis* behavior restricts opportunities for successful chemical control because larvae hatch under the protection of the leaf sheaths and enter the plant stems soon after hatching. Insecticides are also rarely justified in subsistence agriculture with low economic returns which are characteristic of millet production in the Sahel. The cost of insecticides, phytotoxicity, lack of trained applicators, poor to nonexistent extension services for pesticide information, insecticide residues in harvested grains, and the nonavailability of application equipment are serious limitations to insecticide use in subsistence farming (Ndoye et al. 1984; Gahukar 1984b; Nwanze 1985). Chemical control of stem borers is hampered by the fact that the typical stem borer life cycle allows a limited time for contact of borers with insecticides (Ingram 1983). Limitations to insecticide use in subsistence farming systems in West Africa have been discussed by Youm et al. (1990).

Regulatory and Legislative Control

There are no quarantine regulations to control the millet stem borer. The use of quarantine against a widespread indigenous pest species is

rarely justified. The information on the geographic range of the pest should be useful in defining regulations for confining it to current areas.

Other Control Methods

Light trapping

Adult population monitoring has generally been based on light traps (Harris 1962; Bako 1977; Lukefahr 1989b; Gahukar 1990). However, the use of light traps for population monitoring and management of the millet stem borer is often difficult, outside research stations, especially in remote rural areas. The development of a pheromone trapping system may solve this problem and can be an important tool in IPM.

Pheromone trapping

Monitoring. Female pheromone activity was reported in Niger by Bako (1977) and ICRISAT Sahelian Center (1993). Aspects of *C. ignefusalis* biology involving female pheromone based on age and trap height have been studied at the ICRISAT Sahelian Center (Youm et al. 1993a). The potential for using pheromones to control *C. ignefusalis* has also been reported in Niger by Youm et al. (1993a). A water-based pheromone trap made from local material was shown to be an efficient monitoring tool (Youm and Beevor 1995) (Fig. 11).



Figure 11. Water-based pheromone trap for monitoring adult male populations of *Coniesta ignefusalis* (Youm and Beevor 1995).

standardized methods for assessing crop losses should be developed. Methods to determine quickly the relationship between borer density and yield loss in farmers' fields should also be produced. Such rapid and reliable methods would be useful in surveys covering large areas in sub-Saharan Africa especially in the Sahelian and Sudano-Sahelian zones.

Biology and Ecology

Much work has been done on the bioecology of *C. ignefusalis*. However, many basic and strategic aspects of the research need to be addressed:

- Adult behavior and movements need to be studied further to find out if there are migratory patterns.
- How far can moths fly? Do infesting populations emerge locally or are they a result of moths migrating from remote infested areas?
- Do adult females mate once or many times?
- Are there mating deterrents?
- How does the dry season population carry-over relate to rainy-season population incidence? Can this be accurately predicted in a structured sampling and modelling?
- What is the role of alternate host-plants and how do borer populations on these affect those on millet?

Pest Management

Research on *C. ignefusalis* management received much attention in the 1980s. However, aspects of research on pheromones as a method of control have been carried out only in the early 1990s. More reliable screening techniques for host-plant resistance need to be developed.

- Further research is needed on factors linked to oviposition nonpreference, such as length and densities of trichomes.
- No information is available on economic damage thresholds levels (ETLs) for *C. ignefusalis*.
- What is the role of the two "inhibitory" components identified in *C. ignefusalis* pheromone?
- What are the possibilities of survival and establishment of exotic parasites of *C. ignefusalis*?
- What are farmers' perceptions of the economic importance of *C. ignefusalis* and how does this compare or relate to scientists' perceptions?
- There is a need to train farmers on basic insect bioecology.

- Locally-made diet for mass producing *C. ignefusalis* should be improved.

Current trends and findings in *C. ignefusalis* research are very encouraging and a concerted effort of NARS, IARC, nongovernmental organizations (NGO), and regional institutions, involving farmers, should be given a high priority.

References

- Adesiyun, A.A.** 1983. Some effects of intercropping of sorghum, millet and maize on infestation by lepidopterous stalk borers, particularly *Buss-eola fusca*. *Insect Science and its Application* 4:387-391.
- Agnew, C.W.** 1987. Status of *Acigona* Hübner (sensu Bleszynski) (Lepidoptera: Pyralidae: Crambinae) with changes in nomenclature. *Proceedings of the Entomological Society of Washington* 89(1):100-102.
- Ajayi, O.** 1985. The effects of planting date and varieties on stem borer infestation and damage of pearl millet. *Nigerian Journal of Entomology* 6(1-2):71-77.
- Ajayi, O.** 1990. Possibilities for integrated control of the millet stem borer, *Acigona ignefusalis* Hampson (Lepidoptera: Pyralidae) in Nigeria. *Insect Science and its Application* 11(2):109-117.
- Ajayi, O., and Labe, D.A.** 1990. The effects of sowing date and planting method on stem borer damage in *dauro* millet. *Annals of Applied Biology* 111(3):487-494.
- Bako, O.** 1977. Etude biologique de *Haimbachia ignefusalis* (Hamps.) (Lepidoptera: Pyralidae, Crambinae) en vue d'une lutte biologique. MSc Thesis, University of Laval, Quebec, Canada.
- Benoit, P.L.G.,** 1959. Hymenoptera: Ichneumonidae. Banchinae, Bassinae, Pimplinae et Tryphoninae. Pages 441-482 in *South African animal life: results of the Lund University expedition in 1950-51* (Hanström, B., Brinck, P., and Rudebeck, G., eds.). Vol. 6.
- Betbeder-Matibet, M.** 1987. *Acigona ignefusalis* (Hampson), Pyralidae, foreur du mil et du sorgho.

Page(s) ? *in* Insectes nuisibles aux cultures vivrières d'Afrique, de Madagascar et des Mascareignes. Montpellier, France: Institut de recherches agronomiques tropicales et des cultures vivrières.

Bouchard, D., Ouedraogo, A., and Boivin, G. 1993. Impact de la coupe des tiges sur les larves diapausantes de *Coniesta* (= *Acigona*) *ignefusalis* (Lepidoptera: Pyralidae). *Insect Science and its Application* 14:31-37.

Elemo, K.A., and Ajayi, O. 1989. Effects of nitrogen on stem borer damage in sorghum/millet mixture. *Insect Science and its Application* 10(5):601-605

Gahukar, R.T. 1982. Biological control of insect pests of sorghum and pearl millet in West Africa. Pages 69-91 *in* Biological control of pests, its potential in West Africa: proceedings of an International Conference, 9-13 Feb 1981, Dakar, Senegal. USA: USAID Regional Food Crop Protection Project.

Gahukar, R.T. 1984a. Rapport d'activité de l'année 1983. Programme d'entomologie. Projet CILSS de lutte intégrée. Niore du Rip, Sénégal: Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel.

Gahukar, R.T. 1984b. Insect pests of pearl millet in West Africa: a review. *Tropical Pest Management* 30:142-147.

Gahukar, R.T., Guevremont, H., Bhatnagar, V.S., Doumbia, Y.O., NDoeye, M., and Pierrard, G. 1986. A review of the pest status of the millet spike worm *Raghuva albipunctella* (De Joannis) (Noctuidae: Lepidoptera) and its management in the Sahel. *Insect Science and its Application* 7:457-463.

Gahukar, R.T. 1989. Insect pests of millet and their management: a review. *Tropical Pest Management* 35:382-391.

Gahukar, R.T. 1990. Population ecology of *Acigona ignefusalis* (Lepidoptera: Pyralidae) in Senegal. *Environmental Entomology* 19:558-564.

Gahukar, R.T. 1992. Effect of various fertilizers and rates on insect pest/pearl millet relationship in Senegal. *Tropical Agriculture (Trinidad)* 69(2):149-152.

Guevremont, H. 1980. Etudes sur les insectes du mil. Rapport annuel de recherches pour l'année 1979. Maradi, Niger: Laboratoire d'entomologie, Centre national de recherches agronomiques de Tarna.

Guevremont, H. 1983. Recherches sur l'entomofaune du mil. Rapport annuel de recherches pour l'année 1982. Maradi, Niger: Laboratoire d'entomologie, Centre national de recherches agronomiques de Tarna. 69 pp.

Hampson, G.F. 1919. Descriptions of new Pyralidae of the subfamilies Crambinae and Siginae. *Annals and Magazine of Natural History* 3:533-547.

Harris, K.M. 1962. Lepidopterous stem borers of cereals in Nigeria. *Bulletin of Entomological Research* 53(1):139-171.

Harris, K. M., and Nwanze, K.F. 1992. *Busseola fusca* (Fuller), the African maize stalk borer: a handbook of information. Information Bulletin no. 33. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics, and Wallingford, UK: CAB International. 92 pp.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1988. ICRISAT Annual report 1987. Patancheru, A.P. 502 324, India: ICRISAT.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 1991. West African Programs Annual report 1990. Niamey, Niger: ICRISAT Sahelian Center.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 1993. West African Programs Annual report 1992. Niamey, Niger: ICRISAT Sahelian Center.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 1994. West African Programs Annual Report 1993. Niamey, Niger: ICRISAT Sahelian Center.

Ingram, W.R. 1983. Biological control of gramineaceous stem borers and legume pod borers. *Insect Science and its Application* 4(1-2):205-209.

Jepson, W.F. 1954. A critical review of the world literature on the lepidopterous stalk borers of tropical graminaceous crops. London, UK: Commonwealth Institute of Entomology. 127 pp.

Lukefahr, M.J. 1988. Summary of 1987 pearl millet entomology research activities. Niamey, Niger: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Sahelian Center. 17 pp. (Semiformal publication.)

Lukefahr, M.J., Mamalo, A.K., and Klaij, M.C. 1988. Survival of the millet stem borer, *Coniesta (Acigona) ignefusalis* during the non growing season. Pages 31-34 in Proceedings of Regional Millet Workshop IAR-ABU/ICRISAT, Zaria, Nigeria, 15-19 Aug 1988. Niamey, Niger: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Sahelian Center.

Lukefahr, M.J. 1989a. Considerations in the development of a host-plant resistance program against the pearl millet stem borer. Pages 145-149 in International Workshop on Sorghum Stem Borers, 17-20 Nov 1987, ICRISAT Center, India. Patancheru, India: International Crops Research Institute for the Semi-Arid Tropics.

Lukefahr, M.J. 1989b. Summary of 1988 pearl millet entomology research activities. Niamey, Niger: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Sahelian Center. 30 pp. (Semiformal publication.)

Lukefahr, M.J. 1990. Summary of 1989 pearl millet entomology research activities. Niamey, Niger: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Sahelian Center. 31 pp. (Semiformal publication.)

Maiga, S. D. 1984. Premier séminaire régional de formation. Projet amélioration des mil, sorgho, niébé et maïs (18 Avril-2 Mai). Maradi, Niger: Laboratoire d'entomologie, Centre national de recherches agronomiques de Tarna. 45 pp.

Maiga, S.D., and Issa, H. 1988. Les principaux insectes nuisibles aux cultures pluviales (mil, niébé, sorgho et arachide). Pages 41-62 in Manuel de l'expérimentation en plein champ, à l'image des cadres du développement agricole (Reddy, K.C., A. Berrada, and A. Bonkoula, ed.). Niamey,

Niger: Institut national de recherches agronomiques du Niger.

Mamalo, A. K. 1990. Perspectives pour une approche intégrée de lutte contre *Coniesta (= Acigona) ignefusalis* Hampson (Lepidoptera: Pyralidae, Crambinae) borer de tige du mil en zone sahélienne. Thesis, University of Ouagadougou, Burkina Faso. 116 pp.

Markham, R.H. 1985. Natural enemies of *Acigona ignefusalis* and *Raghuva albipunctella* in Niger and Burkina Faso, and possibilities for development of a biological control strategy. Report of a consultancy for ICRISAT Sahelian Center, Niger. Niamey, Niger: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Sahelian Center. 31 pp. (Semiformal publication.)

Mohyuddin, A.L., and Greathead, D.J. 1970. An annotated list of the parasites of graminaceous stem borers in East Africa, with a discussion of their potential in biological control. *Entomophaga* 15(1):241-274.

NDoye, M. 1977. Synthèses de quelques résultats sur les insectes foreurs des mils et sorgho au Sénégal. Bambey, Senegal: Centre national de recherches agronomiques. 15 pp.

NDoye, M. 1979. Un facteur important limitant la productivité des céréales de cultures exondées dans le Sahel Africain: le problème des déprédateurs. Pages 491-499 in Compte rendu des travaux, Congrès sur la lutte contre les insectes en milieu tropical, 13-16 Mar 1979, Marseilles, France. Part 1. Marseilles, France: Chambre de commerce et d'industrie.

NDoye, M. 1980. *Goniozus proceræ* Risbec (Hymenoptera, Bethyilidae), ectoparasite larvaire d'*Acigona ignefusalis* (Hamp.) (Lep. Pyralidae). *Bulletin de l'IFAN T. 42, Ser. A, 2:394-400.*

NDoye, M., Gahukar, R.T., Carson, A.G., Selvaraj, C., M'baye, D.F., and Diallo, S. 1984. Situation of plant protection problems of millet crop in the Sahel. Presented at the International Seminar of CILSS Pest Management Project, 6-13 Dec, Niamey. Nioro du Rip, Sénégal: Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel. 18 pp.

- NDoye, M., and Gahukar, R.T.** 1987. Insect pests of pearl millet in West Africa and their control. Pages 195–205 in Proceedings of the International Pearl Millet Workshop, 7–11 Apr 1986. ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.
- Nwanze, K.F.** 1985. Some aspects of pest management and host plant resistance in pearl millet in the Sahel. *Insect Science and its Application* 6:461–465.
- Nwanze, K.F.** 1989. Insect pests of pearl millet in Sahelian West Africa. I. *Acigona ignefusalis* (Pyralidae, Lepidoptera): distribution, population dynamics and assessment of crop damage. *Tropical Pest Management* 35:137–142.
- Nwanze, K.F., and Mueller, R.A.E.** 1989. Management options for sorghum stem borers for farmers in the semi-arid tropics. Pages 105–113 in International Workshop on Sorghum Stem Borers, 17–20 Nov 1987, ICRISAT Center, India. Patancheru, AP 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.
- Polaszek, A., and Kimani, S.** 1990. *Telenomus* species (Hymenoptera: Scelionidae) attacking eggs of pyralid pests (Lepidoptera) in Africa: a review and guide to identification. *Bulletin of Entomological Research* 80:57–71.
- Risbec, J.** 1950. La faune entomologique des cultures au Sénégal et au Soudan français. Dakar, Senegal: Gouvernement général de l'Afrique occidentale française. 498 pp.
- Risbec, J.** 1960. Les parasites des insectes d'importance économique. *Agronomie Tropicale* 15: 624–656.
- Swaine, G.** 1957. The maize and sorghum stalk borer, *Busseola fusca* (Fuller) in peasant agriculture in Tanganyika Territory. *Bulletin of Entomological Research* 48:711–722.
- Uvah, I.I., and Ajayi, O.** 1989. Chemicals for control of stem borers of pearl millet. Pages 16–22 in Proceedings of the Regional Pearl Millet Improvement Workshop, 4–7 Sep 1989. ICRISAT Sahelian Center, Niger (Fussell, L.K., and Werder, J., ed.). Niamey, Niger: ICRISAT Sahelian Center.
- Vercambre, B.** 1978. *Raghuva* spp. et *Masalia* sp., chenilles des chandelles du mil en zone sahélienne. *Agronomie Tropicale* 33:62–79.
- Walker, A.K.** 1994. Species of microgastrinae ((Hymenoptera: Braconidae) parasitizing lepidopterous cereal stem borers in Africa. *Bulletin of Entomological Research* 84:421–434.
- Youm, O.** 1990. Evaluation of natural enemies associated with the millet stem borer, *Haimbachia ignefusalis* (Hampson) (Lepidoptera: Pyralidae) in Niger. PhD thesis, Texas A&M University, College Station, Texas, USA. 145 pp.
- Youm, O., and Beevor, P.S.** 1995. Field evaluation of pheromone-baited traps for *Coniesta ignefusalis* (Lepidoptera: Pyralidae) in Niger. *Journal of Economic Entomology* 88(1):65–69.
- Youm, O., and Gilstrap, F.E.** 1993a. Population dynamics and parasitism of *Coniesta* (= *Haimbachia*) *ignefusalis*, *Sesamia calamistis*, and *Heliocheilus albipunctella* in millet monoculture. *Insect Science and its Application*. 14:419–426.
- Youm, O., and Gilstrap, F.E.** 1993b. A note on the bioecology of the millet stem borer, *Coniesta* (= *Haimbachia*) *ignefusalis* (Lepidoptera: Pyralidae) in Niger. *Samaru Journal of Agricultural Research* 10:97–104.
- Youm, O., Mamalo A.K., and Nwanze., K.F.** 1993a. Bioecology and integrated management of the millet stalk borer (Lepidoptera: Pyralidae): A review and highlights of current research at the ICRISAT Sahelian Center. Pages: 55–63 in Proceedings of the Regional Pearl Millet Workshop, 19–21 Sep 1990, ICRISAT Sahelian Center, Niger (Youm, O., and Anand kumar, K., eds.). Niamey, Niger: ICRISAT Sahelian Center.
- Youm, O., Beevor, P. S., and Hall, D.R.** 1993b. Trap design studies with the pheromone of *Coniesta ignefusalis* (Hampson) (Lepidoptera: Pyralidae) in sub-saharan Africa. *IOBC WPRS Bulletin* 16 (10)58–63.
- Youm, O., and Gilstrap, F.E.** 1994. Habitat site selection, crop damage and oviposition preference by *Coniesta* (= *Haimbachia*) *ignefusalis* (Lepidoptera: Pyralidae). *International Journal of Pest Management* 40(3):231–236.

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Part 2

Annotated Bibliography

1950-1994

**Compiled by
S Prasannalakshmi**

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Introduction

This bibliography is issued as Part 2 of 'Coniesta ignefusalis (Hampson), the millet stem borer: a handbook of information'. It contains 148 references and includes both conventional and non-conventional literature collected from published primary and secondary sources, computer-readable databases, and reference lists in papers.

References in the bibliography are arranged under broad subject headings, and alphabetically by authors under each heading. Annotations are prepared for entries wherever the original documents were available. In some cases secondary source annotations or abstracts were edited for the bibliography. A few entries do not have annotations as original documents were not accessible. Annotations have been slanted to cover aspects relevant to *C. ignefusalis*. References are cited in ICRISAT style.

References are repeated under more than one subject heading as appropriate. As a result, the number of entries in the bibliography is 203, al-

though the number of unique references is 148. This is also reflected in the author index. Two or more postings against an author does not necessarily mean as many unique references under that author in the bibliography.

The bibliography contains references to literature dealing specifically with *C. ignefusalis*. As a result, some of the references listed in Part 1 may not find a place in the bibliography.

About 75% of the documents listed in the bibliography are held by the ICRISAT Library. The bibliography is also available as an application under the Micro database management software for microcomputers developed and distributed by, and available free of charge to nonprofit organizations. Interested organizations must apply to the ICRISAT Library to get the *C. ignefusalis* database.

The ICRISAT Library will keep this bibliography updated. However, updates will only be provided on demand, either as hardcopy or on diskettes. Any additions to this bibliography are welcome.

General

001

Ahmadou, N. 1986. [Annual report, Entomology (millet, cowpea, groundnut).]. Rapport annuel, Entomologie (mil, niébé, arachide). (In Fr.). Kollo, Niger: INRAN (Institut national de recherches agronomiques du Niger). 20 pp.

Studies on insect pests of millet including *Haimbachia ignefusalis* [*Coniesta ignefusalis*] in Niger are reported. Differences in varietal response to borer infestation are shown.

002

Ajayi, O. 1980. Insect pests of millet in Nigeria. Samaru Miscellaneous Paper no. 97. Samaru, Zaria, Nigeria: Institute for Agricultural Research. 9 pp.

Literature on insect pests of millet in Nigeria including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed.

003

Ajayi, O., and Uvah, I.I. 1989. Review of research on millet entomology in Nigeria: 1977-1987. Page(s) 21-30 in Proceedings of the Regional Pearl Millet Improvement Workshop, 15-19 Aug 1988, Samaru, Nigeria (Fussel, L.K. and Werder, J., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 16 ref.

Coniesta ignefusalis is one of the pests reviewed.

004

Bague, M. 1987. [Stem borer of millet, *Acigona ignefusalis*.]. Le borer de tiges du mil, *Acigona ignefusalis*. (In Fr.). Niamey, Niger: Département de formation en protection des végétaux.

005

Bal, A.B. 1992. [Major insect pests of millet in Senegal: infestation and control methods.]. Les principaux insectes du mil au Senegal: importance du parasitisme et méthodes de lutte. (In Fr.). Page(s) 13-23 in La lutte intégrée contre les ennemis des cultures vivrières dans le Sahel: Deuxième Séminaire sur la lutte intégrée contre les ennemis des cultures vivrières dans le Sahel, 4-9 Jan 1990, Bamako, Mali. Montrouge, France: John Libbey Eurotext. [Also issued as Sahel PV Info 41:2-10.].

The literature on biology, economic importance, varietal resistance, and control methods of major

pearl millet pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed.

006

CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 1989. [Stem borers.]. Les foreurs des tiges. (In Fr.). Bulletin Thematique no. 2. Ouagadougou, Burkina Faso: CILSS. 14 pp.

This bibliography on cereal stem borers includes *Coniesta ignefusalis*.

007

Gahukar, R.T. 1984. Insect pests of pearl millet in West Africa: a review. Tropical Pest Management 30(2): 142-147. 22 ref.

Literature on the biology, distribution, hosts, natural enemies, and control measures of insect pests of pearl millet including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed.

008

Gahukar, R.T. 1989. Insect pests of millets and their management: a review. (Summary(s) in Fr.). Tropical Pest Management 35(4): 382-391. 181 ref.

Acigona ignefusalis [*Coniesta ignefusalis*] is one of the pests of pearl millet reviewed.

009

Gahukar, R.T., Bhatnagar, V.S., Bos, W.S., and Ndoye, M. 1987. Pearl millet entomology research in Senegal. Page(s) 295 in Proceedings of the International Pearl Millet Workshop, 7-11 Apr 1986, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Insect pests of pearl millet including *Acigona ignefusalis* [*Coniesta ignefusalis*] and their natural enemies were surveyed and their importance under subsistence farming conditions was evaluated.

010

Harris, K.M. 1962. Lepidopterous stem borers of cereals in Nigeria. Bulletin of Entomological Research 53: 139-171. 19 ref.

Distribution, life cycle, severity of damage, assessment of yield losses and control measures of *Coniesta ignefusalis* are discussed.

011

Harris, K.M. 1989. Recent advances in sorghum and pearl millet stem borer research. (Summary(s) in Fr.). Page(s) 9–16 in International Workshop on Sorghum Stem Borers, 17–20 Nov 1987, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 46 ref.

Literature published since 1980 on biology, ecology and control of stem borers including *Coniesta ignefusalis* is reviewed.

012

INRAN (Institut national de recherches agronomiques du Niger). 1982. [Stem borer, a serious pest of millet.]. Un sérieux ennemi du mil, le borer des tiges. (In Fr.). Entomologie Fiche no. 9. Niamey, Niger: INRAN. 3 pp.

Description, biology, and control strategies of *Haimbachia ignefusalis* [*Coniesta ignefusalis*] are given. Egg, larval and pupal parasites, and fungal pathogens of the pest are described.

013

IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières). 1987. [*Acigona ignefusalis* (Hampson). Pyralidae. Millet and sorghum stem borer.]. *Acigona ignefusalis* (Hampson). Pyralidae. Foreur du mil et du sorgho. (In Fr.). Montpellier, France: IRAT. 2 pp.

Notes on the recognition, host plants, biology, injuriousness and control of *Acigona ignefusalis* [*Coniesta ignefusalis*] in West Africa are provided. Cultural control and use of early varieties are recommended.

014

Jepson, W.F. 1954. A critical review of the world literature on the lepidopterous stalk borers of tropical graminaceous crops. London, UK: Commonwealth Institute of Entomology. 127 pp.

Identification, host plants, bionomics, population estimation and damage assessment, natural enemies, and control of stem borers including *Chilo ignefusalis* [*Coniesta ignefusalis*] are reviewed. Recommendations for future research on stem borers are outlined.

015

Lankoande, A. 1989. [Lepidopterous stem borers of cereals (sorghum, millet, maize): seasonal variation, economic importance and possible control methods.]. Les lépidoptères foreurs de tige

des céréales (sorgho, mil, maïs): fluctuations saisonnières, importance économique et possibilité de lutte. (In Fr.). Thesis, Université de Ouagadougou, Ouagadougou, Burkina Faso. 61 pp.

Literature on four cereal stem borers including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed. Population dynamics of the borers were compared in sorghum, millet, and maize in Senegal. Yield loss and varietal response for borer damage in sorghum and maize were evaluated.

016

Maiga, S., and Issa, H. 1988. [Principal insect pests of rainfed crops (millet, cowpea, sorghum and groundnut).]. Les principaux insectes nuisibles aux cultures pluviales (mil, niébé, sorgho et arachide). (In Fr.). Page(s) 41–62 in Manuel de l'expérimentation en plein champ, à l'usage des cadres de développement agricole (Reddy, K.C., Berrada, A., and Bonkoula, A., eds.). Niamey, Niger: INRAN (Institut national de recherches agronomiques du Niger).

The description, biology, nature of damage and control measures of major pests including *Haimbachia ignefusalis* [*Coniesta ignefusalis*] on rainfed crops of Niger are given.

017

Mbaye, D.F. 1992. [Pests of millet in Sahel.]. Les ennemis du mil au Sahel. (In Fr.). Page(s) 1–12 in La lutte intégrée contre les ennemis des cultures vivrières dans le Sahel: Deuxième séminaire sur la lutte intégrée contre les ennemis des cultures vivrières dans le Sahel, 4–9 Jan 1990, Bamako, Mali. Montrouge, France: John Libbey Eurotext.

Literature on diseases and pests of millet including *Acigona ignefusalis* [*Coniesta ignefusalis*] in Sahel is reviewed.

018

NDoye, M., and Gahukar, R.T. 1989. [Insect pests of pearl millet in Sahel.]. Les insectes ravageurs du mil à chandelles dans le Sahel. (In Fr.). African Journal of Plant Protection 4(2): 44 pp.

The most damaging insect pests of pearl millet, including *Coniesta ignefusalis*, are described with particular reference to their identification, biology, damage, and control techniques.

019

Nwanze, K.F. 1985. Pearl millet entomology at ISC. Page(s) 33–46 in Record of the Regional Workshop on Pearl Millet Improvement, 31 Aug –

4 Sep 1984, Niamey, Niger. Niamey, Niger: ICRI-SAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

Research techniques and results obtained from work conducted in Niger and Burkina Faso on *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Raghuva albipunctella* are presented.

020

Nwanze, K.F., and Harris, K.M. 1992. Insect pests of pearl millet in West Africa. Review of Agricultural Entomology 80(12): 1133-1155. 97 ref.

Literature on biology, economic importance and control of insect pests including *Coniesta ignefusalis* is reviewed with recommendations on future research.

021

Nwasike, C., Baker, E.F.I., and Egharevba, P.N. 1982. The potential for improving millet (*Pennisetum typhoides* (Burm.), Stapf and Hubb) in farming systems of the semi-arid areas of Nigeria. Agriculture and Environment 7: 15-21. 17 ref.

Acigona ignefusalis [*Coniesta ignefusalis*] is one of the three major insect pests of millet in Nigeria. An alternative approach to improving millet by breeding for pest and disease resistance, reduced plant bulk, and improved grain protein quality, is proposed.

022

Projet Nigéro-Canadien de protection des végétaux Phase IV. 1988. [Major pests of millet in Niger and their control.]. Principaux ennemis du mil au Niger et leur contrôle. (In Fr.) ED: 2nd edn. Niamey, Niger: Coopération Nigéro-Canadienne. 28 pp.

Twenty economically important insect species, including *Coniesta ignefusalis*, reported to attack millet in Niger are described with particular reference to their damage, identification, biology, and control methods.

023

UCTR/PV (Unité de coordination technique régionale en protection des végétaux). (No date.). [Pests of food crops in Sahel.]. Les ennemis des cultures vivrières dans le Sahel. (In Fr.). Bamako, Mali: Institut du Sahel. 127 pp.

Host plants, distribution, biology, types of damage, and resulting symptoms, and control methods are described for *Coniesta ignefusalis* in the Sahel.

Descriptions (Taxonomy)

024

Agnew, C.W. 1987. Status of *Acigona* Hübner (sensu Bleszynski) (Lepidoptera: Pyralidae: Crambinae) with changes in nomenclature. Proceedings of the Entomological Society of Washington 89(1): 100-102. 14 ref.

The genus *Acigona* was proposed by Hübner (1826) for two species without a type species being designated. *Acigona* is composed of genus level taxa which should not be considered congeneric. Some contributions towards nomenclature stability are offered.

Biology, ecology, pest status, and crop loss assessment

025

Adesiyun, A.A. 1993. Seasonal abundance and life history of the millet stem borer, *Coniesta ignefusalis* Hampson (Lepidoptera: Pyralidae) in Samaru, Nigeria. (Summary(s) in Fr.). Insect Science and its Application 14(5-6): 589-593.

Populations of *Coniesta ignefusalis* were monitored in Nigeria between 1973 and 1980 using a light trap. Two generations of the insect/year were represented by two adult peaks in July and September. In 1974, an early peak in May resulted in three generations. In cages in the field, eggs were laid between the leaf sheath and the stem in batches of 20 to 70 with a mean of 47.5 eggs/batch. Laboratory studies conducted at 25-28 deg C and 75-85 per cent r.h. showed an average developmental period of 35.5 days. The average duration of the egg, larval and pupal stages were 4.5, 21.9, and 9.2 days, respectively. Unfed adults lived for 5.3 days.

026

Ajayi, O. 1985. The effects of planting date and varieties on stem borer infestation and damage of pearl millet. Nigerian Journal of Entomology 6: 71-77. 2 ref.

Early planting resulted in least infestation and damage by *Acigona ignefusalis* [*Coniesta ignefusalis*] in three consecutive years at Samaru, Nigeria. Of three millet types *dauro* was the most heavily infested, followed by *gero*. The least infestation and damage occurred in *maiwa*.

027

Ajayi, O. 1987. The status of millet entomology in Nigeria. Page(s) 295–296 in Proceedings of the International Pearl Millet Workshop, 7–11 Apr 1986, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

About 161 insect species are associated with the millet crop in Nigeria. *Acigona ignefusalis* [*Coniesta ignefusalis*] is listed as one of the major pest species.

028

Ajayi, O. 1989. Stem borers of sorghum in West Africa with emphasis on Nigeria. Page(s) 27–31 in International Workshop on Sorghum Stem Borers, 17–20 Nov 1987, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 16 ref.

Acigona ignefusalis [*Coniesta ignefusalis*] is a minor pest of sorghum in a sorghum/millet intercrop.

029

Bako, O. 1977. [Biological and ecological study of *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) for biological control.]. Etude biologique et écologique de *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) en vue d'une lutte biologique. (In Fr.). Thesis, Université Laval, Quebec, Canada. 61 pp.

Host plant–insect pest–parasitoid interactions of pearl millet and *Haimbachia ignefusalis* [*Coniesta ignefusalis*] were studied in Niger. Seven Hymenoptera parasites, three Diptera parasites, and one fungus are listed. The potential of controlling this borer through crop residue destruction, use of sex pheromones, and natural enemies is discussed.

030

Bal, A.B. 1988. [Summary report of the research activities – 1987.]. Rapport de synthèse des activités de recherches – 1987. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques).

Population dynamics and control methods of *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Raghuva albipunctella* were studied at Senegal.

031

Bal, A.B. 1989. [Analytical report of research activities – 1988.]. Rapport analytique des activités de recherches – 1988. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques).

Population of *Acigona ignefusalis* [*Coniesta ignefusalis*] was insignificant at Bambey, Senegal. Stem borer attack was very low on farmers' fields during the vegetative stages of crop growth of pearl millet but increased during crop maturity.

032

Bal, A.B. 1989. [*Coniesta* (*Acigona*) *ignefusalis* Hmps. and *Heliocheilus* (*Raghuva*) *albipunctella* Joanis, pests of millet in Senegal: population dynamics and infestations in the field.]. *Coniesta* (*Acigona*) *ignefusalis* Hmps. et *Heliocheilus* (*Raghuva*) *albipunctella* de Joanis, ravageurs du mil au Sénégal: dynamique des populations imaginaires et infestations au champ. (Summary(s) in En.). Page(s) 11–20 in Proceedings of the Regional Pearl Millet Improvement Workshop, 15–19 Aug 1988, Samaru, Nigeria (Fussell, L.K., and Werder, J., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

The results of monitoring adult population levels of *Coniesta ignefusalis* in 1985–87 using a Robinson electric light trap are reported. The number of insects was not affected by the amount of precipitation, the average daily temperature or the relative humidity. Two generations of the insects were caught in 1985 and 1987 and one in 1986, between 12 and 51 days after the first rains.

033

Bal, A.B. 1990. [Report of activities – 1989: Department of Millet/Cowpea Entomology.]. Rapport d'activité – 1989: du Service d'entomologie mil/niébé. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques).

Population dynamics of insect pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] was studied on pearl millet at Senegal. Two distinct population peaks were observed. Infestation of A.

ignefusalis was low compared to other insect pests.

034

Bal, A.B. 1993. [Major insect pests of food crops in Sahel.]. Principaux insectes ravageurs des cultures vivrières au Sahel. (In Fr.). Sahel PV Info 52: 2-10.

A list of economically important pests and aspects of the bioecology of some of them are given. *Coniesta ignefusalis* is reported as a major stem borer of millet in Sahel.

035

Belko, H. 1989. [Effects of nitrogen on population dynamics of millet stem borer: *Coniesta (Acigona) ignefusalis* (Lepidoptera, Pyralidae, Crambinae)]. Effets de l'azote sur la dynamique de population du borer de tige de mil: *Coniesta (Acigona) ignefusalis* (Lépidoptère Pyralidae, Crambinae). (In Fr.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 40 pp.

Coniesta ignefusalis infestation increased with fertilizer (calcium ammonium nitrate 26 per cent N) application but infestation was relatively moderate when 45 kg ha⁻¹ was applied. Various combinations of phosphorous and nitrogen fertilizers resulted in differences in stem borer infestation and yield.

036

Bhatnagar, V.S. 1983. [Report of activities (June - October 1982), Biological Control Program.]. Rapport d'activité (juin - octobre 1982), Programme de lutte biologique. (In Fr.). Nioro-du-Rip, Senegal: CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 28 pp.

Coniesta ignefusalis was among several insect pests of pearl millet recorded in light traps at Nioro-du-Rip and at Bambey, Senegal. Borer population was low until the end of September. *Coniesta* larvae were recovered from infested millet stems and overlapping generations were observed. Four species of larval parasites, two tachnides and two ichneuminides were recorded.

037

Bhatnagar, V.S. 1985. [Technical report (November 1983 - December 1984), Biological Control Program.]. Rapport technique (novembre 1983 - décembre 1984), Programme de lutte biologique.

(In Fr.). Nioro-du-Rip, Senegal: CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 60 pp.

Adult population dynamics of some biocontrol agents and pests of various crops in Senegal were studied using light and yellow traps. *Coniesta* infestation was lowest on sorghum monocrop, moderate on sorghum/millet intercrop, and highest on millet monocrop. Infestation was generally higher in millet grown close to trees.

038

Bosque-Perez, N.A., and Mareck, J.H. 1990. Distribution and species composition of lepidopterous maize borers in southern Nigeria. Bulletin of Entomological Research 80: 363-368. 22 ref.

Coniesta ignefusalis was found on maize in all four locations in Nigeria in 1985 trials. It constitutes a relatively minor proportion of the borer population.

039

Bouchard, D., and Ouedraogo, A. (No date.). [Millet Project.]. Projet mil. (In Fr.). Page(s) 1-2 in Résumé de rapport annuel de recherches, campagne 1988-1989. Bobo-Dioulasso, Burkina Faso: Ministère de l'Agriculture et de l'Élevage.

Summary of results of the 1988-1989 rainy season experiments on pearl millet is given. Three generations of *Acigona ignefusalis* [*Coniesta ignefusalis*] were observed. A contagious distribution was shown. The evolution of the larval population on cut and uncut stems at the time of harvest were also studied.

040

Breniere, J. 1970. [Entomological research on sorghum and millet in francophone West Africa.]. Recherches entomologiques effectuées en Afrique de l'Ouest francophone en matière de sorgho et de mil. (In Fr.). African Soils 15(1-3): 85-91.

Coniesta ignefusalis was the most abundant stem borer in eastern Senegal. Differences in borer damage on early and late sowing of two millet varieties are reported. Larval parasitization by *Syzeuctus ruberimus senegalensis* was recorded.

041

Breniere, J. 1971. [Problems of the lepidopterous borers of graminiae in West Africa.]. Les problèmes des lépidoptères foreurs des graminées en Afrique de l'Ouest. (In Fr.). Annales de Zoologie et Ecologie Animale 3(3): 287-296.

The major stem borers of cereals are presented. *Acigona ignefusalis* [*Coniesta ignefusalis*] is predominant on pearl millet in West Africa, particularly in eastern Senegal and northern Nigeria. Various control methods are discussed in the light of resource-poor farmers.

042

Breniere, J., and Coutin, R. 1969. [Observations on millet insect pests in eastern Senegal.]. Observations entomologiques sur les insectes du mil au Sénégal oriental. (In Fr.). Paris, France: IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières). 28 pp.

Acigona ignefusalis [*Coniesta ignefusalis*] was the most abundant of all the millet stem borers in Senegal. Souna millet suffered more borer damage when sown in mid-July than in the last week of June or in the beginning of August.

043

Chid, S.R. 1993. [Constraints of pearl millet in Mauritania.]. Contraintes du petit mil en Mauritanie. (In Fr.). Page(s) 115-121 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

Millet production constraints, including *Coniesta ignefusalis*, are presented in relation to ecological zones in Mauritania.

044

CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 1987. [Millet.]. Mil. (In Fr.). Page(s) 17-29 in Recherche et développement de la lutte intégrée contre les principaux ennemis des cultures dans le Sahel: compte rendu de la Réunion technique annuelle des groupes de travail, 2-7 Feb 1987, Banjul, Ouagadougou, Burkina Faso. Ouagadougou, Burkina Faso: CILSS.

The occurrence of *Acigona ignefusalis* [*Coniesta ignefusalis*] in Niger, Burkina Faso, Mali, and the Gambia, level of infestation in Senegal and types of crop damage to pearl millet are given. Varietal differences are highlighted. The recommendations of a working group include studies on yield losses, residue destruction, and varietal resistance.

045

Dakouo, D., and Lankoande, A. 1992. [Lepidopterous stem borers on sorghum: seasonal variation, economic importance and prospect for integrated pest management.]. Les lépidoptères foreurs de tige du sorgho: fluctuations saisonnières, importance économique et perspectives de lutte intégrée. (In Fr.). Page(s) 102-109 in La lutte intégrée contre les ennemis des cultures vivrières dans le Sahel: Deuxième séminaire sur la lutte intégrée contre les ennemis des cultures vivrières dans le Sahel, 4-9 Jan 1990, Bamako, Mali. Montrouge, France: John Libbey Eurotext.

Acigona ignefusalis [*Coniesta ignefusalis*] was predominant on sorghum in Burkina Faso in wet region (700-1400 m). Seasonal variation, economic importance and prospects for integrated management of borers are discussed.

046

Den Boer, L. 1987. [Applied entomology.]. Entomologie appliquée. (In Fr.). Niamey, Niger: Département de formation en protection des végétaux.

Coniesta ignefusalis is included as one of the lepidopterous pests of maize in Sahel.

047

Doumbia, Y.O., and Bonzi, S.M. 1989. [Inventory and distribution of millet and sorghum insects in Mali.]. Inventaire et distribution des insectes du mil et du sorgho au Mali. (In Fr.). Agronomie Tropicale 44(3): 185-195.

Information obtained from research station and farmers' fields on insect pests of pearl millet and sorghum in Mali showed that *Coniesta ignefusalis*, among others, is considered the most severe on pearl millet. In some areas, severe attacks resulted in a shift from the cultivation of souna millet to sorghum.

048

Elomo, K.A., and Ajayi, O. 1989. Effects of nitrogen on stem borer damage in sorghum/millet mixture. Insect Science and its Application 10(5): 601-605. 10 ref.

Pearl millet and sorghum grain yield and stem borer infestation were not significantly influenced by rate and time of nitrogen application. *Acigona ignefusalis* [*Coniesta ignefusalis*] infestation was very severe on pearl millet during the wet seasons of 1984 and 1985, at Samaru, Nigeria

in 1984 resulting in total crop failure. The positive association of nitrogen level and number of borer holes per stem and the percentage of stem tunnelled implies that nitrogen may predispose pearl millet to damage by the stem borer.

049

Fofana, A., and Mbaye, D.F. 1993. [Millet production in Senegal: research constraints and prospects.]. Production du mil au Sénégal: contraintes et perspectives de recherches. (In Fr.). Page(s) 134-141 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

Millet production constraints, including *Coniesta ignefusalis*, are presented in relation to ecological zones in Senegal.

050

Froelich, W., Buah, S.S.J., and Tanzubil, P.B. 1993. A review of millet production and improvement in Ghana. Page(s) 110-114 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

Coniesta ignefusalis is identified as one of the major pests of pearl millet in Ghana.

051

Gahukar, R.T. 1990. Population ecology of *Acigona ignefusalis* (Lepidoptera: Pyralidae) in Senegal. Environmental Entomology 19(3): 558-564. 11 ref.

Acigona ignefusalis [*Coniesta ignefusalis*] produced two or three generations in a crop season with maximum activity in August-October. Vertical distribution of borers in the pearl millet plant was influenced by insect feeding site, plant height, stalk thickness, internodes, and stalk condition. Partial burning of infested green stalks was effective in controlling the pest.

052

Gaya, A. 1987. [Study of some aspects of diapause in *Raghuva* and *Acigona*, pests of millet.]. Etude de certains aspects de la diapause chez *Raghuva* et *Acigona*, ennemis de mil. (In Fr.).

Thesis, Institut pratique de développement rural, Kolo, Niger. 60 pp.

Larval diapause in *Acigona* [*Coniesta ignefusalis*] was studied in the laboratory. Diapause termination was associated with humidity and exposure to light for 13 hours per day was optimum for pupation.

053

Guevremont, H. 1980. [Study of millet insects: annual report of research for the year 1979.]. Etudes sur les insectes du mil: rapport annuel de recherches pour l'année 1979. (In Fr.). Maradi, Niger: CNRA (Centre national de recherches agronomiques de Tarna), and INRAN (Institut national de recherches agronomiques du Niger). 54 pp.

A detailed inventory of millet pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] is provided. Pest population levels and the extent of damage caused are reported. Stem infestation ranged between 55 and 90 depending on variety and planting date. Based on entry/exit holes, stem breakage and proportion of infested internodes, the variety 3/4 HK was less susceptible to infestation than CIVT and HKP. Susceptibility of CIVT and HKP decreased with a delay in sowing date, while 3/4 HK showed no significant change.

054

Guevremont, H. 1981. [Research on insect pests of millet: annual research report for the year 1980. 2nd part.]. Recherches sur l'entomofaune du mil: rapport annuel de recherches pour l'année 1980. Deuxième partie. (In Fr.). Maradi, Niger: CNRA (Centre national de recherches agronomiques de Tarna), and INRAN (Institut national de recherches agronomiques du Niger). 35 pp.

Haimbachia ignefusalis [*Coniesta ignefusalis*] is listed among 80 insect pests of pearl millet in Tarna, Niger. Stem infestation, internode damage, and frequency of borer holes varied between 1979 and 1980 and was attributed to location of experimental plots.

055

Guevremont, H. 1982. [Study of the head miner and other insect pests of millet: annual research report for the year 1981.]. Etudes sur la mineuse de l'épi et autres insectes du mil, rapport annuel de recherches pour l'année 1981. (In Fr.). Maradi, Niger: CNRA (Centre national de recherches

agronomiques de Tarna), and INRAN (Institut national de recherches agronomiques du Niger). 63 pp.

Coniesta ignefusalis is listed as one of the important insect pests of pearl millet. Stem borer populations were observed from July through October 1981 with generally low population densities and damage.

056

Guevremont, H. 1983. [Research on insect pests of millet: annual research report for 1982.]. Recherches sur l'entomofaune du mil: rapport annuel de recherches pour 1982. (In Fr.). Maradi, Niger: CNRA (Centre national de recherches agronomiques de Tarna), and INRAN (Institut national de recherches agronomiques du Niger). 76 pp.

Coniesta ignefusalis is listed among 80 insect pests of pearl millet in Tarna, and around Maradi, Niger, in 1982. Adult population levels were lower than in 1980 and 1981. Three generations were recorded. Among four millet varieties tested, damage increased in P3Kolo with delay in sowing date.

057

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1979. Progress in sorghum entomology. Page(s) 255-256 in Annual report 1977-1978. Patancheru, A.P. 502 324, India: ICRISAT.

During rainy season of 1977, none of the borers including *Acigona ignefusalis* [*Coniesta ignefusalis*] was reported on sorghum in Senegal. *A. ignefusalis* was predominant in the south and *Contarinia sorghicola* in the center of the region.

058

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1980. Progress in sorghum entomology. Page(s) 263-264 in Annual report 1978-1979. Patancheru, A.P. 502 324, India: ICRISAT.

Work at Senegal on sorghum entomology is reported. *Acigona ignefusalis* [*Coniesta ignefusalis*] infestation on sorghum was highest (11 per cent of plants attacked) in Sefa. *Acigona* was more important in early sowings of the local cultivar Congossame. *Acigona* was reared in the laboratory using fresh sorghum material.

059

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1981. Progress in millet entomology. Page(s) 283-284 in Annual report 1979/80. Patancheru, A.P. 502 324, India: ICRISAT.

Work on millet entomology in Senegal and Upper Volta [Burkina Faso] is reported. *Acigona ignefusalis* [*Coniesta ignefusalis*] was found to be damaging on pearl millet in research stations in Senegal. Incidence was greater in the high rainfall zone (900-1000 mm) than in the drier Sahelian zone (about 300 mm) in Upper Volta.

060

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1981. Progress in sorghum entomology. Page(s) 271-273 in Annual report 1979/80. Patancheru, A.P. 502 324, India: ICRISAT.

Work on sorghum entomology in Senegal and Upper Volta [Burkina Faso] is reported. *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Sesamia* sp. were important on local and improved sorghums in Senegal. Of three cultivars examined for borer incidence at harvest, MN-1056 was susceptible to *Acigona*.

061

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1982. Sorghum and pearl millet entomology. Page(s) 320-321 in Annual report 1981. Patancheru, A.P. 502 324, India: ICRISAT.

Work on sorghum and pearl millet entomology in Upper Volta [Burkina Faso], Niger and Nigeria are covered. The distribution of the stem borers were closely related to rainfall. In the drier regions severity of attack was less. Damage by *Acigona* [*Coniesta*] infestation was less after a legume-cereal-legume rotation than in a continuous cereal crop system. Planting date and crop residue removal did not show any effect on borer infestation.

062

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1983. Sorghum and pearl millet entomology. Page(s) 363-372 in Annual report 1982. Patancheru, A.P. 502 324, India: ICRISAT.

Work on sorghum and pearl millet entomology at Niger, Nigeria, and Burkina Faso are reported. *Acigona ignefusalis* [*Coniesta ignefusalis*] was the predominant borer of pearl millet in October and November in Kamboinse, Burkina Faso. In Nigeria, *Busseola fusca* accounted for 90 per cent of the borers on sorghum and remaining 10 per cent was made up by *A. ignefusalis*. The borer was predominant on the late-planted millet.

063

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1984. Pearl millet. International cooperation. Insect pests. Page(s) 100-103 in Annual report 1983. Patancheru, A.P. 502 324, India: ICRISAT.

Activities of the Entomology Program in Niger are reported. *Acigona* [*Coniesta ignefusalis*] was recorded in all millet-growing locations in Niger. The borer was most devastating under irrigated conditions in late May.

064

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1984. Pearl millet. Stem borer (*Acigona ignefusalis*). Page(s) 109 in Annual report 1983. Patancheru, A.P. 50 324, India: ICRISAT.

Incidence and fluctuation of *Acigona ignefusalis* [*Coniesta ignefusalis*] on pearl millet were monitored at Niger. Borer incidence and diapausing larval populations were lower in 1984 than in 1983. Higher levels of borer damage were noticed on late-sown millet.

065

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1985. Pearl millet. Insect pests. Page(s) 98-99 in Annual report 1984. Patancheru, A.P. 502 324, India: ICRISAT. Populations of *Acigona ignefusalis* [*Coniesta ignefusalis*], were monitored in Niger. There was a declining trend in the borer infestation during 1983-85.

066

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1987. Pearl millet. Insect pests. Page(s) 83-86 in Annual report 1986. Patancheru, A.P. 502 324, India: ICRISAT. The level of stem borer, *Acigona ignefusalis* [*Coniesta ignefusalis*], infestation at Niger in 1986 was 81 larvae/100 stems at peak infestation in Sep-

tember in Niger. Of the two primary parasites, *Euwipio rufa* and *Syzeuctus* sp., *Syzeuctus* sp. was more abundant.

067

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1988. Pearl millet. Stem borer [*Coniesta (Acigona) ignefusalis*]. Page(s) 91-93 in Annual report 1987. Patancheru, A.P. 502 324, India: ICRISAT.

Studies in Niger on the biology, larval survival and time of pupation, relationship between larval populations and exit holes, crop loss assessment, effect of carbofuran on borer populations and evaluation of sources of resistance are summarized.

068

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1989. Pearl millet. Stem borer [*Coniesta (Acigona) ignefusalis*]. Page(s) 36-37 in Annual report 1988. Patancheru, A.P. 502 324, India: ICRISAT.

Sampling methods to estimate larval numbers, augmentation of natural populations and behavior patterns of *Coniesta ignefusalis* on pearl millet were studied at Niger. Larval exit holes gave a reliable estimate of larval populations. Uniform infestations were achieved by placing infested stems in test area and regulating the emergence pattern of adults. Active components of pheromones determined and seven trap designs were evaluated.

069

Ikwelle, M.C., Labe, D.A., and Nwasike, C.C. 1993. Millet production in Nigeria: constraints and prospects. Page(s) 122-126 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

Coniesta ignefusalis is identified as one of the three major pearl millet pests in Nigeria.

070

INTSORMIL (International Sorghum/Millet, Collaborative Research Support Program (CRSP)). 1988. Niger. Page(s) 255-262 in Annual report 1987. Lincoln, Nebraska, USA: INTSORMIL.

Haimbachia ignefusalis [*Coniesta ignefusalis*] is briefly covered in the country report of Niger under millet entomology.

071

Jago, N.D., Rowley, J.Q., and West, C. (No date.). Mali Millet Pest Control Project technical report 1985-87. Kent, UK: Overseas Development Natural Resources Institute. 66 pp. 14 ref.

Although *Acigona ignefusalis* [*Coniesta ignefusalis*] is locally abundant in the project area, it did not cause significant grain loss. Chemical control is not recommended as it is expensive.

072

Jallow, M.F.A. 1993. Pearl millet production and research in the Gambia. Page(s) 107-109 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for Semi-Arid Tropics) Sahelian Center.

Coniesta ignefusalis was one of the major insect pests reducing yields of pearl millet in the Gambia.

073

Lankoande, A. 1989. [Lepodopterous stem borers of cereals (sorghum, millet, maize): seasonal variation, economic importance and possible control methods.]. Les lépidoptères foreurs de tige des cereales (sorgho, mil, mais): fluctuations saisonnières importance économique et possibilités de lutte. (In Fr.). Thesis, Université de Ouagadougou, Ouagadougou, Burkina Faso. 61 pp.

Literature on four cereal stem borers including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed. Population dynamics of the borers were compared in sorghum, millet, and maize in Senegal. Yield loss and varietal response for borer damage in sorghum and maize were evaluated.

074

Lukefahr, M.J. 1988. Summary of 1987 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 24 pp. (Limited distribution.).

Results of studies on the biology of *Coniesta ignefusalis* and identification of resistance of pearl millet and yield loss assessment are presented.

075

Lukefahr, M.J. 1989. Summary of 1988 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 27 pp. (Limited distribution.).

Results of studies on *Coniesta ignefusalis* on the biology, cultural control, pheromone traps, and crop loss assessment are presented.

076

Lukefahr, M.J. 1990. Summary of 1989 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 23 pp. (Limited distribution.).

Results of studies on screening methodology and identification of resistance of pearl millet to *Coniesta ignefusalis* are presented. Information on the sex pheromone and trap design, biocology, and crop loss assessment is also included.

077

Lukefahr, M.J., Mamalo, A.K., and Nwanze, K.F. 1989. A note on the occurrence of a seasonal quiescence in the millet stem borer, *Coniesta (Acigona) ignefusalis*. (Summary(s) in Fr.). Page(s) 35-37 in Proceedings of the Regional Pearl Millet Improvement Workshop, 15-19 Aug 1988, Samaru, Nigeria (Fussel, L.K., and Werder, J., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 2 ref.

A seasonal quiescence (arrested development) was evident during 1987 in the middle of the growing season when there was no significant rainfall for 36 days in Niger.

078

Lukefahr, M.J., Mamalo, A.K., and Klaij, M.C. 1989. Survival of millet stem borer (*Coniesta (Acigona) ignefusalis*) during the non-growing season. (Summary(s) in Fr.). Page(s) 31-34 in Proceedings of the Regional Pearl Millet Improvement Workshop, 15-19 Aug 1988, Samaru, Nigeria (Fussel, L.K., and Werder, J., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

During 1986-1987 and 1987-88 dry seasons in Niger, high temperature reduced larval populations of *Coniesta ignefusalis*. The survival of lar-

vae in standing stalks was greater than those on the soil-surface or buried five cm.

079

Maiga, S.D. 1984. [Insects of cereals.]. Insectes des céréales. (In Fr.). Page(s) 2-21 in Premier séminaire régional de formation, Projet amélioration des mils, sorgho, niébé et maïs: Entomologie, 18 Apr - 2 May 1984, Maradi and Tarna. Maradi, Niger: INRAN (Institut national de recherches agronomiques du Niger).

The principal pests of millet, including *Haimbachia ignefusalis* [*Coniesta ignefusales*] in the Sahel are covered. Their morphology, geographical distribution, damage, and periods of activity are reported. Integrated pest management strategies are briefly discussed.

080

Maiga, S.D. 1987. [Integrated control project for the pests of major food crops in Sahel. Annual report 1986, Millet Entomology.]. Projet de lutte intégrée contre les ennemis des principales cultures vivrières dans le Sahel. Rapport annuel 1986, Entomologie - Mil. (In Fr.). Maradi, Niger: CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 48 pp.

An inventory of millet insects in the Sahel is given. Due to more than normal rainfall in 1986, *Acigona ignefusalis* [*Coniesta ignefusalis*] infestation levels of 50-100 per cent were observed in the region.

081

Muhtari, A.K. 1993. Highlights of millet research in Nigeria during the 1989 season. Page(s) 130-133 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, A., eds.). Niamey, Niger: ICRISAT (International Crops Research Center for the Semi-Arid Tropics) Sahelian Center.

Summary of insect pests collected on pearl millet during 1989 survey at 4 stations of northeastern Nigeria is given. Infestation by *Coniesta ignefusalis* on millet plant was 25 per cent and 50 per cent at Ngalda and Maiduguri, respectively.

082

NDoye, M. 1980. [Problem of stem borers and midge of millet in Sefa-Maniora: report of the rainy season 1979.]. Problème du borer de la tige et des cécidomyies des graines de mil dans la zone de Sefa-Maniora: profil de la campagne d'hiver-

nage 1979. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques), and ISRA (Institut sénégalais de recherches agricoles). 22 pp.

Results of experiments in 1979 on the population dynamics, crop damage, and control methods of *Acigona ignefusalis* [*Coniesta ignefusalis*] and midge species of pearl millet in Sefa-Maniora zone of Senegal are reported. Pearl millet was preferred to sorghum by the borer. Application of Furadan at 450 g a.i. ha⁻¹ gave satisfactory control.

083

NDoye, M. 1981. [Biology of *Acigona ignefusalis* Hmps. (Lepidoptera, Pyralidae, Crambinae) the stem borer of millet in Senegal.]. Contribution à la connaissance de la biologie d'*Acigona ignefusalis* Hmps. (Lépidoptère, Pyralidae, Crambinae) foreur de la tige de mil au Sénégal. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques), and ISRA (Institut sénégalais de recherches agricoles). 25 pp.

Larval development of *Acigona ignefusalis* [*Coniesta ignefusalis*] towards diapause can be identified by the progressive disappearance of black spots on the body. Sowing at the beginning of the season protected millet from the borer attack.

084

NDoye, M. 1989. [Agricultural production and protection of crops in the Sahelian zone of West Africa.]. Productions agricoles et systèmes de protection des cultures et des récoltes stockées dans la zone sahélienne de l'Afrique occidentale. (In Fr.). African Journal of Plant Protection 4(1): 123 pp.

Coniesta ignefusalis is listed as an important pest in the drier areas of the Sahel. A brief description of the distribution, bioecology, damage, and control techniques is provided. Crop residue destruction is listed as a management option which might conflict with farmer's use of stems. Varieties INMB 106 and INMB 155 were tolerant of stem borer.

085

NDoye, M., and Gahukar, R.T. 1987. Insect pests of pearl millet in West Africa and their control. Page(s) 195-205 in Proceedings of the International Pearl Millet Workshop, 7-11 Apr 1986, ICRISAT Center, India. Patancheru, A.P. 502

324, India: International Crops Research Institute for the Semi-Arid Tropics. 43 ref.

Information on the ecology and control measures of insect pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed.

086

Nwanze, K.F. (No date.). Stem-borers of cereals in Sahelian West Africa: relative importance and control. Page(s) 115-123 in *Biological control of pests: its potential in West Africa: proceedings of an International Conference, 9-13 Feb 1981, Dakar, Senegal*. Dakar, Senegal: US Agency for International Development Regional Food Crop Protection Project. 14 ref. [Also issued in Fr.: Pages 108-115 in *Lutte biologique contre les ravageurs et ses possibilités en Afrique de l'Ouest: compte rendu du Séminaire qui a eu lieu, 9-13 Fev 1981, Dakar, Senegal.*].

Acigona ignefusalis [*Coniesta ignefusalis*] is the predominant borer on millet and is more widely distributed in the Sahel than *Busseola fusca*. It is more prevalent in the North, than in the South on sorghum. Various cultural measures, use of resistant varieties, and release of biological control agents, are reviewed in the context of integrated pest management.

087

Nwanze, K.F. 1981. Annual report 1980. Section F: Entomology. Ougadougou, Burkina Faso: ICRI-SAT (International Crops Research Institute for the Semi-Arid Tropics) Upper Volta Cooperative Program. (Limited distribution.).

Pest infestations in Upper Volta [Burkina Faso] are more severe in the South where rainfall exceeds 900 mm. Borer infestation of millet caused primarily by *Acigona ignefusalis* [*Coniesta ignefusalis*] is higher and more extensive than in sorghum. Stem infestation and internode damage increase with a delay in planting. Intercropping with legume and phosphate fertilizer application increased borer infestation.

088

Nwanze, K.F. 1988. Assessment of on-farm losses in millets due to insect pests. (Summary(s) in Fr.). *Insect Science and its Application* 9(6): 673-677. 15 ref.

Information from trials and surveys that have been used in West Africa to assess crop losses due to *Acigona ignefusalis* [*Coniesta ignefusalis*] and

Raghuva albipunctella is provided. Crop loss assessment methods using incidence and damage ratios are discussed.

089

Nwanze, K.F. 1988. Distribution of seasonal incidence of some major insect pests of sorghum in Burkina Faso. (Summary(s) in Fr.). *Insect Science and its Application* 9(3): 313-321. 14 ref.

Results of extensive pest surveys conducted on farmers' fields and pest population studies between 1979 and 1981 are presented. *Acigona ignefusalis* [*Coniesta ignefusalis*] infested sorghum in the North but did not show any definite population pattern. The increase in *Acigona* infestation in October and November corresponded with high levels of *Acigona* in pearl millet during that period.

090

Nwanze, K.F. 1989. Insect pests of pearl millet in Sahelian West Africa. 1. *Acigona ignefusalis* (Pyralidae, Lepidoptera): distribution, population dynamics and assessment of crop damage. *Tropical Pest Management* 35(2): 137-142. 12 ref.

Acigona ignefusalis [*Coniesta ignefusalis*] is widely distributed in West Africa but its occurrence and severity of infestation varies between locations and years. Two generations of moth population with peaks in July and September are reported. Diapausing larval population declined during the dry season from November to May. Crop infestation was associated by rainfall pattern. Stem damage was low in early sown millet. The local cultivar was the least affected by the borer damage.

091

Pierrard, G., and Ba, D. 1986. [Use of agrometeorology in controlling the insect pests of food crops in Sahel.]. Utilisation de l'agrométéorologie dans la lutte contre les ravageurs des plantes vivrières dans le Sahel. (In Fr.). Page(s) 71-80 in *Comptes rendus du Colloque sur l'agroclimatologie, 8-12 décembre 1986, Bambey, Senegal*. Bambey, Senegal: CIRAD (Centre de coopération internationale en recherche agronomique pour le développement), and IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières).

An overview of Sahelian pests and their control methods is presented. An exhaustive

agrometeorological study to understand the migratory patterns of *Acigona ignefusalis* [*Coniesta ignefusalis*] and to establish the relation between first generation population size and that of later generations is suggested.

092

Sigisbert, D.Y., and Yehouenou, A. 1993. [Agricultural research and extension in Benin.]. Structure de la recherche agronomique et relation avec la vulgarisation au Bénin. (In Fr.). Page(s) 79-81 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, K.A., eds). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

Coniesta ignefusalis is listed among millet production constraints in Benin.

093

Soumana, I. 1976. [Radioactive marker for millet borer in dry season.]. Le marquage radioactif de chenilles de saison sèche de la pyrale du mil. (In Fr.). Page(s) 107-129 in Procès-verbal du Symposium international sur les déprédateurs au champ de l'arachide et du mil, 21-23 Apr 1976, Kaolack, Senegal. Lagos, Nigeria: Conseil africain de l'arachide.

Experiments designed to monitor absorption patterns of radioactive compounds by caterpillars of *Haimbachia ignefusalis* [*Coniesta ignefusalis*] for possible radioactive labelling are described. Among the four compounds tested, cobalt gave the best results.

094

Soumana, I. 1976. [Use of light traps for monitoring millet borers in Niamey and Dosso during 1974 rainy season.]. Piégeage lumineux de la pyrale du mil dans les départements de Niamey et de Dosso pendant la saison pluvieuse de l'année 1974. (In Fr.). Page(s) 96-105 in Procès-verbal du Symposium international sur les déprédateurs au champ de l'arachide et du mil, 21-23 Apr 1976, Kaolack, Senegal. Lagos, Nigeria: Conseil Africain de l'Arachide.

The population dynamics of *Haimbachia ignefusalis* [*Coniesta ignefusalis*] was monitored, using light traps, from July to September in the Niamey and Dosso provinces. Four peaks were recorded; the highest being the second which oc-

curred from 12 Aug to 2 Sep and coincided with panicle exertion.

095

Taneja, S.L., and Nwanze, K.F. 1989. Assessment of yield loss of sorghum and pearl millet due to stem borer damage. Page(s) 95-105 in International Workshop on Sorghum Stem Borers, 17-20 Nov 1987, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 6 ref.

Tiller infestation by *Coniesta ignefusalis* and internode damage were higher in the late-sown crop of pearl millet than in the early-sown crop in Niger. Insecticide protection under low borer damage resulted in a slight increase in grain yield in the non-protected over the protected crop.

096

Teetes, G.L., and Gilstrap, F.E. (No date.). Niger research on head bugs of sorghum and stem borers of millet. (Summary(s) in En, Fr.). Page(s) 163-168 in Niger Sorghum and Millet Workshop, 13-17 Oct 1985, Niamey, Niger (Axtell, J.D., and Clark, J.W., eds.). West Lafayette, Indiana, USA: INTSORMIL (International Sorghum/Millet, Collaborative Research Support Program (CRSP)).

Over 10 per cent of millet stalks were infested by *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Sesamia* spp. Of the eight biological control agents emerging from borers, *Syzeuctus senegalensis* was the most abundant parasite.

097

Teetes, G.L., and Gilstrap, F.E. 1988. Development and evaluation of systems for controlling insect pests of sorghum/millet by integration of resistant varieties, cultural manipulation and biological control. Page(s) 149-158 in Annual report 1987. Lincoln, Nebraska, USA: INTSORMIL (International Sorghum/Millet, Collaborative Research Support Program (CRSP)).

The methods and findings of the collaborative research project on insect pests of sorghum and millet in Niger are summarized. Population dynamics in millet monoculture, ecology and parasitism in alternate host plants and distribution of damage and diapausing larvae in dry mature millet plants are the topics investigated on *Haimbachia* [*Coniesta ignefusalis*].

098

Teetes, G.L., and Gilstrap, F.E. 1991. Development and evaluation of systems for controlling insect pests of sorghum/millet by integration of resistant varieties, cultural manipulation and biological control. Page(s) 125-130 in Annual report 1990. Lincoln, Nebraska, USA: INTSORMIL (International Sorghum/Millet, Collaborative Research Support Program (CRSP)).

Dr. Youm's studies on host plants, natural enemies, oviposition behavior, effects on crop loss, survival in excised millet stalks, and population dynamics of *Haimbachia ignefusalis* [*Coniesta ignefusalis*] are reported.

099

Tiarson, N.J.M. 1994. [Incidence of *Coniesta ignefusalis*, *Heliocheilus albipunctella* and *Rhinyptia infusata* on intercropped millet in Niger.]. Incidences des attaques de *Coniesta ignefusalis*, *Heliocheilus albipunctella*, et *Rhinyptia infusata* sur le mil dans les associations culturales au Niger. (In Fr.). Thesis, Université de Ouagadougou, Ouagadougou, Burkina Faso. 113 pp.

Results of evaluation of millet-based cropping systems under natural infestation of *Coniesta ignefusalis*, *Heliocheilus albipunctella*, and *Rhinyptia infusata*, are presented. Intercropping millet with cowpea (1:1) had no effect on millet stem borer and head miner incidence. When millet is grown under *Faidherbia albida* canopy, damage to millet as well as infestation by *C. ignefusalis* were significantly increased.

100

UCTR/PV (Unité de coordination technique régionale en protection des végétaux). 1991. [Workshop on Millet Yield Loss in Sahel: proceedings, 20-22 Mar 1991, Ouagadougou, Burkina Faso.]. Colloque sur le profil des pertes sur le mil dans le Sahel: comptes rendus, 20-22 mars 1991, Ouagadougou, Burkina Faso. (In Fr.). Ouagadougou, Burkina Faso: Institut du Sahel. 30 pp.

Methods for estimating crop losses developed by various projects in the Sahel are reviewed. A chemical control method that is used to evaluate millet crop losses due to *Coniesta ignefusalis* during the vegetative phase is described.

101

UCTR/PV (Unité de coordination technique régionale en protection des végétaux). 1992. [Crop

protection in Sahel: proceedings of the Annual Meeting 23-27 Mar 1992, Dakar, Senegal.]. Protection des végétaux dans le Sahel: comptes rendus de la réunion annuelle, 23-27 mars 1992, Dakar, Senegal. (In Fr.). Bamako, Mali: Institut de Sahel. 86 pp.

Research by plant protection agencies and extension services in different Sahelian countries is reported. The incidence and levels of infestation of *Coniesta ignefusalis* in the Gambia and in Mali are reported.

102

Vercambre, B. 1986. [Role of hydrological factor on population dynamics of some insect pests of millet in Senegal.]. Rôle du facteur hydrique sur la dynamique de quelques insectes ravageurs du mil au Sénégal. (In Fr.). Page(s) ? in Comptes rendus du Colloque sur l'agroclimatologie, 8-12 décembre 1986, Bambey, Senegal. Bambey, Senegal: CIRAD (Centre de coopération internationale en recherche agronomique pour le développement), and IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières).

Major pests of millet in Senegal including *Acigona* [*Coniesta*], *Raghuva*, *Geromiya*, *Amsacta* and *Spodoptera* are studied. Borer incidence and some control methods are discussed.

103

Yehouenou, A. 1987. Pearl Millet Improvement Program (Entomology Subprogram): final report of a study, 3 Aug - 7 Nov 1987. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 19 pp. 11 ref. (Limited distribution.).

Yield loss due to the damage by *Coniesta ignefusalis* on pearl millet is assessed. High correlation was obtained between number of exit holes and number of larvae in the main stem. This relationship provides an estimation of relative infestation among millet cultivars.

104

Youm, O., and Gilstrap, F.E. 1993. A note on the bioecology of the millet stem borer, *Coniesta* (= *Haimbachia*) *ignefusalis* (Lepidoptera: Pyralidae) in Niger. (Summary(s) in Fr.). Samaru Journal of Research 10: 97-103. [Presented at the 22nd Annual Conference of the Entomological So-

ciety of Nigeria, 7–11 Oct 1990, Ahmadu Bello University, Samaru, Zaria, Nigeria.]

The spectrum of crop and non-crop host plants of *Coniesta ignefusalis* and the complex borer/plant/natural enemy interactions in selected millet growing areas in Niger are discussed.

105

Youm, O., and Gilstrap, F.E. 1994. Habitat site selection, crop damage and oviposition preference by *Coniesta (=Haimbachia) ignefusalis* (Lepidoptera: Pyralidae). *International Journal of Pest Management* 40(3): 231–236.

In studies conducted during 1980–88 at Niger pearl millet grain weight was negatively correlated with number of *Coniesta ignefusalis* entry/exit holes. *Coniesta* oviposition occurred within leaf sheaths of green millet plants.

106

Youm, O., Mamalo, A.K., and Nwanze, K.F. 1993. Bio-ecology and integrated management of the millet stem borer (Lepidoptera:Pyralidae): a review and highlights of current research at the ICRISAT Sahelian Center. (Summary(s) in Fr.). Page(s) 55–63 in *Proceedings of the Regional Pearl Millet Workshop, 19–21 Sep 1990, Niamey, Niger* (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 36 ref.

Literature on *Coniesta ignefusalis* is reviewed. Priorities of research at the ICRISAT Sahelian Center include estimation of yield losses, biology as related to laboratory culturing, development of screening techniques, development of effective cultural control methods, identification of borer resistant lines, and search for effective natural enemies.

107

Zangre, R.G., Sedogo, M.C., Sereme, P., Dabire, L.C., and Cisse, Z. 1993. [Principal production constraints of millet and research priorities in Burkina Faso.]. Principales contraintes à la production du mil et priorités de recherche au Burkina Faso. (In Fr.). Page(s) 85–96 in *Proceedings of the Regional Pearl Millet Workshop, 19–21 Sep 1990, Niamey, Niger* (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

Coniesta ignefusalis is listed among the most important insect pests of millet in the Sahelian zone of Burkina Faso.

Pest management (General)

108

Bal, A.B. 1988. [Summary report of the research activities – 1987.]. Rapport de synthèse des activités de recherches – 1987. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques).

Population dynamics and control methods of *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Raghuva albipunctella* were studied at Senegal.

109

Breniere, J. 1971. [Problems of the lepidopterous borers of gramineae in West Africa.]. Les problèmes des lépidoptères foreurs des graminées en Afrique de l'Ouest. (In Fr.). *Annales de Zoologie et Ecologie Animale* 3(3): 287–296.

The major stem borers of cereals are presented. *Acigona ignefusalis* [*Coniesta ignefusalis*] is predominant on pearl millet in West Africa, particularly in eastern Senegal and northern Nigeria. Various control methods are discussed in the light of resource-poor farmers.

110

Gahukar, R.T. 1988. Problems and perspectives of pest management in the Sahel: a case study of pearl millet. *Tropical Pest Management* 34(1): 35–38. 28 ref.

Literature on the economic importance, biology, ecology, and control of insect pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] attacking pearl millet in the Sudano-Sahelian zone of West Africa is reviewed.

111

NDoye, M., and Gahukar, R.T. 1987. Insect pests of pearl millet in West Africa and their control. Page(s) 195–205 in *Proceedings of the International Pearl Millet Workshop, 7–11 Apr 1986, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.* 43 ref.

Information on the ecology and control measures of insect pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed.

112

Nwanze, K.F. 1991. Components for the management of two insect pests of pearl millet in Sahelian West Africa. (Summary(s) in Fr.). *Insect Science and its Application* 12(5-6): 673-678. 29 ref.

Various methods for the control of *Coniesta ignefusalis* Hampson and *Heliocheilus albipunctella* are briefly discussed.

113

Nwanze, K.F., and Mueller, R.A.E. 1989. Management options for sorghum stem borers for farmers in the semi-arid tropics. (Summary(s) in Fr.). Page(s) 105-116 in *International Workshop on Sorghum Stem Borers, 17-20 Nov 1987, ICRI-SAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics*. 33 ref.

Existing control measures against sorghum stem borers including *Acigona ignefusalis* [*Coniesta ignefusalis*] are briefly reviewed. The review indicates that most recommendations are impractical and have not been adopted by farmers in the SAT. A farming systems perspective to stem borer management is stressed.

114

Vercambre, B. 1986. [Role of hydrological factor on population dynamics of some insect pests of millet in Senegal.]. Rôle du facteur hydrique sur la dynamique de quelques insectes ravageurs du mil au Sénégal. (In Fr.). Page(s) ? in *Comptes rendus du Colloque sur l'agrocimatologie, 8-12 décembre 1986, Bambey, Senegal. Bambey, Senegal: CIRAD (Centre de coopération internationale en recherche agronomique pour le développement), and IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières)*.

Major pests of millet in Senegal including *Acigona* [*Coniesta*], *Raghuwa*, *Geromiya*, *Amsacta* and *Spodoptera* are studied. Borer incidence and some control methods are discussed.

Cultural control

115

Ajayi, O. 1985. The effects of planting date and varieties on stem borer infestation and damage of pearl millet. *Nigerian Journal of Entomology* 6: 71-77. 2 ref.

Early planting resulted in least infestation and damage by *Acigona ignefusalis* [*Coniesta ignefusalis*] in three consecutive years at Samaru, Nigeria. Of three millet types *dauro* was the most heavily infested, followed by *gero*. The least infestation and damage occurred in *maiwa*.

116

Ajayi, O., and Labe, D.A. 1990. The effects of sowing date and planting method on stem borer damage in *dauro* millet. *Annals of Applied Biology* 117: 487-494. 7 ref.

In the trials conducted in Samaru, Nigeria in 1983, 1984, and 1985 on *dauro* millet, damage due to *Coniesta ignefusalis* varied between years and dates of planting. Planting between 10 July and 2 August was best for least stem borer damage while planting between 11 and 30 July for maximum yields. The direct sown crop suffered more damage than the transplanted crop.

117

Bako, O. 1977. [Biological and ecological study of *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) for biological control.]. Etude biologique et écologique de *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) en vue d'une lutte biologique. (In Fr.). Thesis, Université Laval, Quebec, Canada. 61 pp.

Host plant-insect pest-parasitoid interactions of pearl millet and *Haimbachia ignefusalis* [*Coniesta ignefusalis*] were studied in Niger. Seven Hymenoptera parasites, three Diptera parasites, and one fungus are listed. The potential of controlling this borer through crop residue destruction, use of sex pheromones, and natural enemies is discussed.

118

Belko, H. 1989. [Effects of nitrogen on population dynamics of millet stem borer: *Coniesta (Acigona) ignefusalis* (Lepidoptera, Pyralidae, Crambinae)]. Effets de l'azote sur la dynamique de population du borer de tige de mil: *Coniesta (Acigona) ignefusalis* (Lépidoptère, Pyralidae, Crambinae). (In Fr.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 40 pp.

Coniesta ignefusalis infestation increased with fertilizer (calcium ammonium nitrate 26 per cent N) application but infestation was relatively moderate when 45 kg ha⁻¹ was applied. Various com-

binations of phosphorous and nitrogen fertilizers resulted in differences in stem borer infestation and yield.

119

Bouchard, D., Ouedraogo, A., and Boivin, G. 1993. [Effect of cutting millet stems on the diapausing larvae of *Coniesta (Acigona) ignefusalis* (Lepidoptera: Pyralidae).]. Impact de la coupe des tiges du mil sur les larves diapausantes de *Coniesta (Acigona) ignefusalis* (Lepidoptera: Pyralidae). (In Fr.). Insect Science and its Application 14(1): 31-37. 18 ref.

Cutting millet stems at harvest reduced the third-generation larvae of *Coniesta ignefusalis* by 76-92 per cent.

120

Breniere, J. 1970. [Entomological research on sorghum and millet in francophone West Africa.]. Recherches entomologiques effectuées en Afrique de l'Ouest francophone en matière de sorgho et de mil. (In Fr.). African Soils 15(1-3): 85-91.

Coniesta ignefusalis was the most abundant stem borer in eastern Senegal. Differences in borer damage on early and late sowing of two millet varieties are reported. Larval parasitization by *Syzeuctus ruberimus senegalensis* was recorded.

121

Breniere, J., and Coutin, R. 1969. [Observations on millet insect pests in eastern Senegal.]. Observations entomologiques sur les insectes du mil au Sénégal oriental. (In Fr.). Paris, France: IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières). 28 pp.

Acigona ignefusalis [*Coniesta ignefusalis*] was the most abundant of all the millet stem borers in Senegal. Souma millet suffered more borer damage when sown in mid-July than in the last week of June or in the beginning of August.

122

CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 1987. [Millet.]. Mil. (In Fr.). Page(s) 17-29 in Recherche et développement de la lutte intégrée contre les principaux ennemis des cultures dans le Sahel: compte rendu de la Réunion technique annuelle des groupes de travail, 2-7 Feb 1987, Banjul, Ouagadougou, Burkina Faso. Ouagadougou, Burkina Faso: CILSS.

The occurrence of *Acigona ignefusalis* [*Coniesta ignefusalis*] in Niger, Burkina Faso, Mali, and the Gambia, level of infestation in Senegal and types of crop damage to pearl millet are given. Varietal differences are highlighted. The recommendations of a working group include studies on yield losses, residue destruction, and varietal resistance.

123

Elemo, K.A., and Ajayi, O. 1989. Effects of nitrogen on stem borer damage in sorghum/millet mixture. Insect Science and its Application 10(5): 601-605. 10 ref.

Pearl millet and sorghum grain yield and stem borer infestation were not significantly influenced by rate and time of nitrogen application. *Acigona ignefusalis* [*Coniesta ignefusalis*] infestation was very severe on pearl millet during the wet seasons of 1984 and 1985, at Samaru, Nigeria in 1984 resulting in total crop failure. The positive association of nitrogen level and number of borer holes per stem and the percentage of stem tunnelled implies that nitrogen may predispose pearl millet to damage by the stem borer.

124

Gahukar, R.T. 1989. Pest and disease incidence in pearl millet under different plant density and intercropping patterns. Agriculture, Ecosystems and Environment 26: 69-74. 11 ref.

Acigona ignefusalis [*Coniesta ignefusalis*] population and spike worm infestation rate in pearl millet were reduced by planting one row of millet with either 10 or 30 cowpea rows.

125

Gahukar, R.T. 1990. Population ecology of *Acigona ignefusalis* (Lepidoptera: Pyralidae) in Senegal. Environmental Entomology 19(3): 558-564. 11 ref.

Acigona ignefusalis [*Coniesta ignefusalis*] produced two or three generations in a crop season with maximum activity in August-October. Vertical distribution of borers in the pearl millet plant was influenced by insect feeding site, plant height, stalk thickness, internodes, and stalk condition. Partial burning of infested green stalks was effective in controlling the pest.

126

Gahukar, R.T. 1992. Effect of various fertilizers and rates on insect pest/pearl millet relationship

in Senegal. *Tropical Agriculture* 69(2): 149–152. 9 ref.

Application of a complete fertilizer dosage at 50–300 kg ha⁻¹, to two pearl millet cultivars, or urea at 50–200 kg ha⁻¹, resulted in significantly increased levels of stalk infestation and larval abundance of *Coniesta ignefusalis* but superphosphate when applied at 50–200 kg ha⁻¹ reduced stalk infestation.

127

Guevremont, H. 1983. [Research on insect pests of millet: annual research report for 1982.]. *Recherches sur l'entomofaune du mil: rapport annuel de recherches pour 1982.* (In Fr.). Maradi, Niger: CNRA (Centre national de recherches agronomiques de Tarna), and INRAN (Institut national de recherches agronomiques du Niger). 76 pp.

Coniesta ignefusalis is listed among 80 insect pests of pearl millet in Tarna, and around Maradi, Niger, in 1982. Adult population levels were lower than in 1980 and 1981. Three generations were recorded. Among four millet varieties tested, damage increased in P3 Kolo with delay in sowing date.

128

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1982. Sorghum and pearl millet entomology. Page(s) 320–321 in *Annual report 1981*. Patancheru, A.P. 502 324, India: ICRISAT.

Work on sorghum and pearl millet entomology in Upper Volta [Burkina Faso], Niger and Nigeria are covered. The distribution of the stem borers were closely related to rainfall. In the drier regions severity of attack was less. Damage by *Acigona* [*Coniesta*] infestation was less after a legume–cereal–legume rotation than in a continuous cereal crop system. Planting date and crop residue removal did not show any effect on borer infestation.

129

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1983. Sorghum and pearl millet entomology. Page(s) 363–372 in *Annual report 1982*. Patancheru, A.P. 502 324, India: ICRISAT.

Work on sorghum and pearl millet entomology at Niger, Nigeria, and Burkina Faso are reported.

Acigona ignefusalis [*Coniesta ignefusalis*] was the predominant borer of pearl millet in October and November in Kamboinse, Burkina Faso. In Nigeria, *Busseola fusca* accounted for 90 per cent of the borers on sorghum and remaining 10 per cent was made up by *A. ignefusalis*. The borer was predominant on the late-planted millet.

130

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1984. Pearl millet. International cooperation. Insect pests. Page(s) 100–103 in *Annual report 1983*. Patancheru, A.P. 502 324, India: ICRISAT.

Activities of the Entomology Program in Niger are reported. *Acigona* [*Coniesta ignefusalis*] was recorded in all millet-growing locations in Niger. The borer was most devastating under irrigated conditions in late May.

131

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1984. Pearl millet. Stem borer (*Acigona ignefusalis*). Page(s) 109 in *Annual report 1983*. Patancheru, A.P. 50 324, India: ICRISAT.

Incidence and fluctuation of *Acigona ignefusalis* [*Coniesta ignefusalis*] on pearl millet were monitored at Niger. Borer incidence and diapausing larval populations were lower in 1984 than in 1983. Higher levels of borer damage were noticed on late-sown millet.

132

IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières). 1987. [*Acigona ignefusalis* (Hampson). Pyralidae. Millet and sorghum stem borer.]. *Acigona ignefusalis* (Hampson). Pyralidae. Foreur du mil et du sorgho. (In Fr.). Montpellier, France: IRAT. 2 pp.

Notes on the recognition, host plants, biology, injuriousness and control of *Acigona ignefusalis* [*Coniesta ignefusalis*] in West Africa are provided. Cultural control and use of early varieties are recommended.

133

Labe, D.A., and Ajayi, O. 1989. Effects of the date and method of planting on the grain yield and yield components of *dauro* millet at Samaru in the Nigerian northern Guinea savanna. (Summary(s) in Fr.). Page(s) 94–102 in *Proceedings of the Regional Pearl Millet Improvement Work-*

shop, 15–19 Aug 1988, Samaru, Nigeria (Fussell, L.K., and Werder, J., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 5 ref.

The productivity of *dauro* millet [pearl millet] was not affected by the combination of planting dates and methods. However, in 1984 number of plants per plot were reduced due to the attack by *Coniesta ignefusalis*.

134

Labe, D.A., Egharevba, P.N., Yoyock, J.Y., and Okiror, S.O. 1987. Effect of planting methods on the performance of *dauro* millet. *Maydica* 32(4): 287–299.

Direct sown *dauro* millet [pearl millet] suffered from highest plant mortality at Zaria and Katak, and *Acigona ignefusalis* [*Coniesta ignefusalis*] attack in Zaria, Nigeria in 1981–82.

135

Lukefahr, M.J. 1989. Summary of 1988 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 27 pp. (Limited distribution.)

Results of studies on *Coniesta ignefusalis* on the biology, cultural control, pheromone traps, and crop loss assessment are presented.

136

Lukefahr, M.J., Mamalo, A.K., and Klaij, M.C. 1989. Survival of millet stem borer (*Coniesta (Acigona) ignefusalis*) during the non-growing season. (Summary(s) in Fr.). Page(s) 31–34 in Proceedings of the Regional Pearl Millet Improvement Workshop, 15–19 Aug 1988, Samaru, Nigeria (Fussell, L.K., and Werder, J., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center.

During 1986–1987 and 1987–88 dry seasons in Niger, high temperature reduced larval populations of *Coniesta ignefusalis*. The survival of larvae in standing stalks was greater than those on the soil-surface or buried five cm.

137

NDoye, M. 1981. [Biology of *Acigona ignefusalis* Hmps. (Lepidoptera, Pyralidae, Crambinae) the stem borer of millet in Senegal.]. Contribution à la connaissance de la biologie d'*Acigona ignefusalis* Hmps. (Lépidoptère, Pyralidae, Cram-

binæ) foreur de la tige de mil au Sénégal. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques), and ISRA (Institut sénégalais de recherches agricoles). 25 pp.

Larval development of *Acigona ignefusalis* [*Coniesta ignefusalis*] towards diapause can be identified by the progressive disappearance of black spots on the body. Sowing at the beginning of the season protected millet from the borer attack.

138

NDoye, M. 1989. [Agricultural production and protection of crops in the Sahelian zone of West Africa.]. Productions agricoles et systèmes de protection des cultures et des récoltes stockées dans la zone sahélienne de l'Afrique occidentale. (In Fr.). *African Journal of Plant Protection* 4(1): 123 pp.

Coniesta ignefusalis is listed as an important pest in the drier areas of the Sahel. A brief description of the distribution, bioecology, damage, and control techniques is provided. Crop residue destruction is listed as a management option which might conflict with farmer's use of stems. Varieties INMB 106 and INMB 155 were tolerant of stem borer.

139

Nwanze, K.F. 1981. Annual report 1980. Section F: Entomology. Ougadougou, Burkina Faso: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Upper Volta Cooperative Program (Limited distribution.)

Pest infestations in Upper Volta [Burkina Faso] are more severe in the South where rainfall exceeds 900 mm. Borer infestation of millet caused primarily by *Acigona ignefusalis* [*Coniesta ignefusalis*] is higher and more extensive than in sorghum. Stem infestation and internode damage increase with a delay in planting. Intercropping with legume and phosphate fertilizer application increased borer infestation.

140

Sagnia, S.B. 1989. Pest control in millet farming. *ILEIA Newsletter* 3(Oct): 15–17. 3 ref.

Larvae of *Coniesta ignefusalis* survive the dry season in infested stalks. Larvae can be destroyed by burning these stalks during land preparation.

141

Tiarson, N.J.M. 1994. [Incidence of *Coniesta ignefusalis*, *Heliocheilus albipunctella* and *Rhiny-*

tia infusata on intercropped millet in Niger.]. Incidences des attaques de *Coniesta ignefusalis*, *Heliocheilus albipunctella*, et *Rhinyptia infusata* sur le mil dans les associations culturales au Niger. (In Fr.). Thesis, Université de Ouagadougou, Ouagadougou, Burkina Faso. 113 pp.

Results of evaluation of millet-based cropping systems under natural infestation of *Coniesta ignefusalis*, *Heliocheilus albipunctella*, and *Rhinyptia infusata*, are presented. Intercropping millet with cowpea (1:1) had no effect on millet stem borer and head miner incidence. When millet is grown under *Faidherbia albida* canopy, damage to millet as well as infestation by *C. ignefusalis* were significantly increased.

Plant resistance

142

Ahmadou, N. 1986. [Annual report, Entomology (millet, cowpea, groundnut).]. Rapport annuel, Entomologie (mil, niébé, arachide). (In Fr.). Kollo, Niger: INRAN (Institut national de recherches agronomiques du Niger). 20 pp.

Studies on insect pests of millet including *Haimbachia ignefusalis* [*Coniesta ignefusalis*] in Niger are reported. Differences in varietal response to borer infestation are shown.

143

Ajayi, O. 1985. The effects of planting date and varieties on stem borer infestation and damage of pearl millet. Nigerian Journal of Entomology 6: 71-77. 2 ref.

Early planting resulted in least infestation and damage by *Acigona ignefusalis* [*Coniesta ignefusalis*] in three consecutive years at Samaru, Nigeria. Of three millet types *dauro* was the most heavily infested, followed by *gero*. The least infestation and damage occurred in *maiwa*.

144

CILSS (Comité permanent inter-Etats de lutte contre la secheresse dans le Sahel). 1987. [Millet.]. Mil. (In Fr.). Page(s) 17-29 in Recherche et développement de la lutte intégrée contre les principaux ennemis des cultures dans le Sahel: compte rendu de la Réunion technique annuelle des groupes de travail, 2-7 Feb 1987, Banjul, Ouagadougou, Burkina Faso. Ouagadougou, Burkina Faso: CILSS.

The occurrence of *Acigona ignefusalis* [*Coniesta ignefusalis*] in Niger, Burkina Faso, Mali, and the Gambia, level of infestation in Senegal and types of crop damage to pearl millet are given. Varietal differences are highlighted. The recommendations of a working group include studies on yield losses, residue destruction, and varietal resistance.

145

Doumbia, Y.O., and Scheuring, J.F. 1982. [Assessment of small millet varieties (*Pennisetum typhoides*) resistant to stem borer (*Acigona ignefusalis* (Lepidopt. Pyral.)).] (In Fr.). Page(s) 1-9 in Commission technique des productions vivrières et oléagineuses. Bamako, Mali: Ministère d'Agriculture.

Of the pearl millet varieties tested for two years in Mali, *Ningali* (cmm-159) was tolerant to *Acigona ignefusalis* [*Coniesta ignefusalis*].

146

Doumbia, Y.O., and Scheuring, J.F. 1983. [Varietal resistance of millet to stem borer (*Acigona ignefusalis*).]. Résistance variétale du mil au borer de tige (*Acigona ignefusalis*). (In Fr.). Page(s) 1-11 in Cellule défense des cultures projet lutte intégrée Mali: résultats campagnes 1982-1983, Entomologie (Doumbia, Y.O., Sidibe, B., Toure, K., and Bonzi, M.S., eds.). Bamako, Mali: Ministère d'Agriculture.

In 1980, out of 352 varieties tested in Mali, early variety *Ningali* (cmm-159) was resistant to *Acigona ignefusalis* [*Coniesta ignefusalis*].

147

Gahukar, R.T. 1990. Field screening of pearl millet cultivars in relation to insects and diseases. (Summary(s) in Fr.). Insect Science and its Application 11(1): 13-19. 16 ref.

Out of 33 cultivars tested during 1985-86 season against natural infestation of *Coniesta ignefusalis*, among other pests and diseases in Senegal, none showed tolerance/resistance to the stalk borer.

148

Gahukar, R.T. 1990. Reaction of locally improved pearl millets to three insect pests and two diseases in Senegal. Journal of Economic Entomology 83(5): 2102-2106. 11 ref.

Eight locally improved pearl millet cultivars were compared with the traditional cultivar *souna* dur-

ing the 1982–1984 crop seasons. Based on level of stalk infestation and number of *Acigona* [*Coniesta ignefusalis*] larvae, none were found resistant.

149

Gougari, B. 1990. [Contribution to the study of varietal resistance of millet to *Coniesta (Acigona) ignefusalis* Hampson (Lepidoptera: Pyralidae: Crambinae) and the biology of the borer.]. Contribution à l'étude de la résistance variétale du mil à *Coniesta (Acigona) ignefusalis* Hampson (Lepidoptera: Pyralidae: Crambinae) et à la biologie du foreur. (In Fr.). Niamey, Niger: Département de formation en protection des végétaux.

The variety ex-Bornu was relatively more infested than CIVT and P3Kolo. Results were inconclusive on aspects of borer biology in relation to different food sources.

150

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1981. Progress in sorghum entomology. Page(s) 271–273 in Annual report 1979/80. Patancheru, A.P. 502 324, India: ICRISAT.

Work on sorghum entomology in Senegal and Upper Volta [Burkina Faso] is reported. *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Sesamia* sp. were important on local and improved sorghums in Senegal. Of three cultivars examined for borer incidence at harvest, MN-1056 was susceptible to *Acigona*.

151

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1988. Pearl millet. Stem borer [*Coniesta (Acigona) ignefusalis*]. Page(s) 91–93 in Annual report 1987. Patancheru, A.P. 502 324, India: ICRISAT.

Studies in Niger on the biology, larval survival and time of pupation, relationship between larval populations and exit holes, crop loss assessment, effect of carbofuran on borer populations and evaluation of sources of resistance are summarized.

152

Lankoande, A. 1989. [Lepidopterous stem borers of cereals (sorghum, millet, maize): seasonal variation, economic importance and possible control methods.]. Les lépidoptères foreurs de tige des céréales (sorgho, mil, maïs): fluctuations saisonnières, importance économique et possi-

bilités de lutte. (In Fr.). Thesis, Université de Ouagadougou, Ouagadougou, Burkina Faso. 61 pp.

Literature on four cereal stem borers including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed. Population dynamics of the borers were compared in sorghum, millet, and maize in Senegal. Yield loss and varietal response for borer damage in sorghum and maize were evaluated.

153

Lukefahr, M.J. 1988. Summary of 1987 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 24 pp. (Limited distribution.).

Results of studies on the biology of *Coniesta ignefusalis* and identification of resistance of pearl millet and yield loss assessment are presented.

154

Lukefahr, M.J. 1989. Considerations in the development of a host-plant resistance program against the pearl millet stem borer. Page(s) 145–150 in International Workshop on Sorghum Stem Borers, 17–20 Nov 1987, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 22 ref.

Several cultivars and breeding lines of pearl millet sustained lower populations of *Coniesta ignefusalis* compared to local landraces.

155

Lukefahr, M.J. 1990. Summary of 1989 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 23 pp. (Limited distribution.).

Results of studies on screening methodology and identification of resistance of pearl millet to *Coniesta ignefusalis* are presented. Information on the sex pheromone and trap design, bioecology, and crop loss assessment is also included.

156

NDoyle, M. 1989. [Agricultural production and protection of crops in the Sahelian zone of West Africa.]. Productions agricoles et systèmes de protection des cultures et des récoltes stockées dans la zone sahélienne de l'Afrique occidentale. (In Fr.). African Journal of Plant Protection 4(1): 123 pp.

Coniesta ignefusalis is listed as an important pest in the drier areas of the Sahel. A brief description of the distribution, bioecology, damage, and control techniques is provided. Crop residue destruction is listed as a management option which might conflict with farmer's use of stems. Varieties INMB 106 and INMB 155 were tolerant of stem borer.

157

Nwanze, K.F. 1985. Some aspects of pest management and host plant resistance in pearl millet in the Sahel. (Summary(s) in Fr.). *Insect Science and its Application* 6(3): 461-465. 19 ref.

The relative importance and significance of host plant resistance in an integrated pest management program is compared against other modalities. Natural enemies appear inefficient in controlling *Acigona ignefusalis* [*Coniesta ignefusalis*].

158

Nwanze, K.F., and Reddy, Y.V.R. 1991. A rapid method for screening sorghum for resistance to *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae). *Journal of Agricultural Entomology* 8(1): 41-49. 11 ref.

The possibility of using the rapid screening method developed for *Chilo partellus* to *Busseola fusca* and *Coniesta ignefusalis* is indicated.

Biological control and natural enemies

159

Bako, O. 1977. [Biological and ecological study of *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) for biological control.]. Etude biologique et écologique de *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) en vue d'une lutte biologique. (In Fr.). Thesis, Université Laval, Quebec, Canada. 61 pp.

Host plant-insect pest-parasitoid interactions of pearl millet and *Haimbachia ignefusalis* [*Coniesta ignefusalis*] were studied in Niger. Seven Hymenoptera parasites, three Diptera parasites, and one fungus are listed. The potential of controlling this borer through crop residue destruction, use of sex pheromones, and natural enemies is discussed.

160

Bhatnagar, V.S. 1983. [Report of activities (June - October 1982), Biological Control Program.]. Rapport d'activité (juin - octobre 1982), Programme de lutte biologique. (In Fr.). Nioro-du-Rip, Senegal: CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 28 pp.

Coniesta ignefusalis was among several insect pests of pearl millet recorded in light traps at Nioro-du-Rip and at Bambey, Senegal. Borer population was low until the end of September. *Coniesta* larvae were recovered from infested millet stems and overlapping generations were observed. Four species of larval parasites, two tachnides and two ichneuminides were recorded.

161

Bhatnagar, V.S. 1984. [Report of activities (November 1982 - October 1983), Biological Control Program.]. Rapport d'activité (novembre 1982-octobre 1983), Programme de lutte biologique. (In Fr.). Nioro-du-Rip, Senegal: CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 80 pp.

Eight parasites were identified on *Acigona ignefusalis* [*Coniesta ignefusalis*] in Senegal: *Sturmiopsis parasitica*, *Goniozus procerae* Risbec, *Liomorpha* sp, *Mesochorus* sp, *Syzeuctus* sp, *Hyperchalcidia soudanensis* Steffan, *Dasyproctus bipunctatus bipunctatus*, and *Mermis* sp.

162

Bhatnagar, V.S., and Dieme, E. 1983. [Report of activities of the dry season (November 1981 - May 1982), Biological Control Program.]. Rapport d'activité de saison sèche (novembre 1981 - mai 1982), Programme de lutte biologique. (In Fr.). Nioro-du-Rip, Senegal: CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 19 pp.

The development of a biological control strategy against the main pests of cereals is attempted. No parasite was found on the diapausing larvae of *Coniesta ignefusalis*. The techniques used for observing parasites need to be improved.

163

Breniere, J. 1970. [Entomological research on sorghum and millet in francophone West Africa.]. Recherches entomologiques effectuées en Afrique

de l'Ouest francophone en matière de sorgho et de mil. (In Fr.). *African Soils* 15(1-3): 85-91.

Coniesta ignefusalis was the most abundant stem borer in eastern Senegal. Differences in borer damage on early and late sowing of two millet varieties are reported. Larval parasitization by *Syzeuctus ruberimus senegalensis* was recorded.

164

CILSS (Comité permanent inter-Etats de lutte contre la sécheresse dans le Sahel). 1983. [Annual technical report, 1983, IPM Project.]. Rapport technique annuel 1983, Projet de lutte intégrée. (In Fr.). Bambey, Senegal: CILSS. 98 pp.

Research activities and results are presented with emphasis on biological control of the main insect pests of pearl millet, including *Coniesta ignefusalis*.

165

Gahukar, R.T. (No date.). Biological control of insect pests of sorghum and pearl millet in West Africa, Dakar, Senegal. Page(s) 69-91 in Biological control of pests: its potential in West Africa: proceedings of an International Conference, 9-13 Feb 1981, Dakar, Senegal. Dakar, Senegal: US Agency for International Development, Regional Food Crop Protection Project. 42 ref. [Also issued in Fr.: Pages 74-83 in Lutte biologique contre les ravageurs et ses possibilités en Afrique de l'Ouest: compte rendu du Séminaire qui a eu lieu, 9-13 Feb 1981, Dakar, Senegal.].

Literature on distribution and biological control of major insect pests of sorghum and pearl millet including *Acigona ignefusalis* [*Coniesta ignefusalis*] is reviewed.

166

Gilstrap, F.E., and Youm, O. 1989. Biological control of millet stalk borer in Niger. Page(s) 159 in Proceedings of the International Sorghum/Millet CRSP Conference, 3-5 Jan 1989, Scottsdale, Arizona, USA. Lincoln, Nebraska, USA: INTSO-RMIL (International Sorghum/Millet, Collaborative Research Support Program (CRSP)).

Out of 14 plant species belonging to seven graminaceous and non-graminaceous families collected in Niger, *Andropogon gayanus* was the most common host of *Haimbachia* [*Coniesta ignefusalis*]. Though several parasites attacked the stem borer in millet, densities of borers were not suppressed by these parasites.

167

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1987. Pearl millet. Insect pests. Page(s) 83-86 in Annual report 1986. Patancheru, A.P. 502 324, India: ICRISAT.

The level of stem borer, *Acigona ignefusalis* [*Coniesta ignefusalis*], infestation at Niger in 1986 was 81 larvae/100 stems at peak infestation in September in Niger. Of the two primary parasites, *Euvipio rufa* and *Syzeuctus* sp., *Syzeuctus* sp. was more abundant.

168

Markham, R.H. 1985. Natural enemies of *Acigona ignefusalis* and *Raghuva albipunctella* in Niger and Burkina Faso and possibilities for development of a biological control strategy: report of a consultancy of ICRISAT Sahelian Center, Niamey. Nairobi, Kenya: Commonwealth Institute of Biological Control, Kenya Station.

Results of the survey of 53 sites showed that *Syzeuctus* sp. was more abundant and widespread than the other two parasites, *Euvipio rufa* and *Hyperchalcidia soudanensis* on *Acigona ignefusalis* [*Coniesta ignefusalis*]. There was no relationship between rate of parasitism and host density. The parasites were ineffective as biological control agents. Possibilities and recommendations for biological control are given.

169

Nagarkatti, S., and Rao, V.P. 1975. Biology of and rearing technique for *Sturmiopsis parasitica* (Curr.) (Diptera, Tachinidae), a parasite of graminaceous borers in Africa. *Bulletin of Entomological Research* 65: 165-170.

Acigona ignefusalis [*Coniesta ignefusalis*] is included in the list of common hosts of *Sturmiopsis parasitica*.

170

NDoye, M. 1980. [*Goniozus proceræ* Risbec (Hymenoptera: Bethyridae), ectoparasitic larvae of *Acigona ignefusalis* Hampson (Lepidoptera, Pyralidae, Crambinae)]. *Goniozus proceræ* Risbec (Hymenopteres, Bethyridae), ectoparasite larvaire d'*Acigona ignefusalis* Hampson (Lepidopteres, Pyralidae, Crambinae). (In Fr.). *Bulletin de l'IFAN* (Senegal) T.42(2): Series A 394-400.

The life cycle and a laboratory technique for rearing *Goniozus proceræ* on diapausing larvae of *Acigona ignefusalis* [*Coniesta ignefusalis*] are

described. Implications of the findings on the future use of the parasite in stem borer biological control are mentioned.

171

Pennards, G.W.A. 1992. [List of parasites of *Coniesta ignefusalis* (Hampson) (Lepidoptera, Pyralidae) and of some lepidopterous pests of food crops in Sahel.]. Inventaire des parasites de *Coniesta ignefusalis* (Hampson) (Lepidoptera, Pyralidae) et de certains lépidoptères ravageurs des cultures vivrières du Sahel. (In Fr.). Niamey, Niger: Département de formation en protection des végétaux.

Coniesta ignefusalis is listed as one of the three major lepidopterous pests of pearl millet and was reported in six different locations. The number, distribution and status as potential biological control agents of the parasites are given.

172

Quicke, D.L.J. 1983. The true identity of reported braconid (Hym.) parasites of *Coniesta ignefusalis* (Kmps.) (Lep., Pyralidae) in Nigeria. Entomologist's Monthly Magazine 119(1424-1427): 94. 3 ref.

Glyptomorpha and *Euwipio* parasitising *Coniesta ignefusalis* in Nigeria are referred to as *Euwipio* sp.

173

Risbec, J. 1960. [Economically important insect pests and their parasites in Tropical Africa and Madagascar.]. Les parasites des insectes d'importance économique en Afrique tropicale et à Madagascar. (In Fr.). Agronomie Tropicale 15(6): 624-656.

A descriptive taxonomic list of millet insect pests of economic importance and associated natural enemies in tropical Africa and Madagascar is presented. Thirteen species of natural enemies that attack *Coniesta ignefusalis* are reported.

174

Teetes, G.L., and Gilstrap, F.E. (No date.). Niger research on head bugs of sorghum and stem borers of millet. (Summary(s) in En Fr.). Page(s) 163-168 in Niger Sorghum and Millet Workshop, 13-17 Oct 1985, Niamey, Niger (Axtell, J.D., and Clark, J.W., eds.). West Lafayette, Indiana, USA: INTSORMIL (International Sorghum/Millet, Collaborative Research Support Program (CRSP)).

Over 10 per cent of millet stalks were infested by *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Sesamia* spp. Of the eight biological control agents emerging from borers, *Syzeuctus senegalensis* was the most abundant parasite.

175

Teetes, G.L., and Gilstrap, F.E. 1989. Development and evaluation of systems for controlling insect pests of sorghum/millet by integration of resistant varieties, cultural manipulation and biological control. Page(s) 143-148 in Annual report 1988. Lincoln, Nebraska, USA: INTSORMIL (International Sorghum/Millet, Collaborative Research Support Program (CRSP)).

The methods and findings of the collaborative research project on insect pests of sorghum and millet in Niger are summarized. Research on biological control of *Haimbachia ignefusalis* [*Coniesta ignefusalis*] includes the identification of the alternate host plants, and the life table studies on the borer to characterize the suppressive impact of extant natural enemies.

176

Youm, O. 1990. Evaluation of natural enemies associated with the millet stalk borer, *Haimbachia ignefusalis* [*Coniesta ignefusalis*] (Hampson) (Lepidoptera: Pyralidae) in Niger. Ph.D. thesis, Texas A & M University, College Station, Texas, USA. 145 pp. 159 ref.

Literature on distribution, biology, host plants and control of major millet pests including *Haimbachia ignefusalis* [*Coniesta ignefusalis*] is reviewed. Results of studies conducted from 1986 to 1988 on *Haimbachia ignefusalis* in Niger are reported on its host plants, natural enemies, and its bioecology including population dynamics, and crop loss. The borer was collected from 14 alternate host plants and was parasitized by a complex of parasite species. *Platytenomus* sp was the most common parasite. Natural enemies did not control the borer on millet. Diapause larvae population declined during the dry season. A model on borer, host plants and natural enemies is proposed.

Chemical control

177

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1988. Pearl mil-

let. Stem borer [*Coniesta (Acigona) ignefusalis*]. Page(s) 91–93 in Annual report 1987. Patancheru, A.P. 502 324, India: ICRISAT.

Studies in Niger on the biology, larval survival and time of pupation, relationship between larval populations and exit holes, crop loss assessment, effect of carbofuran on borer populations and evaluation of sources of resistance are summarized.

178

Jago, N.D., Rowley, J.Q., and West, C. (No date.). Mali Millet Pest Control Project technical report 1985–87. Kent, UK: Overseas Development Natural Resources Institute. 66 pp. 14 ref.

Although *Acigona ignefusalis* [*Coniesta ignefusalis*] is locally abundant in the project area, it did not cause significant grain loss. Chemical control is not recommended as it is expensive.

179

NDoye, M. 1980. [Problem of stem borers and midge of millet in Sefa–Maniora: report of the rainy season 1979.]. Problème du borer de la tige et des céciidomyies des graines de mil dans la zone de Sefa–Maniora: profil de la campagne d'hivernage 1979. (In Fr.). Bambey, Senegal: CNRA (Centre national de recherches agronomiques), and ISRA (Institut sénégalais de recherches agricoles). 22 pp.

Results of experiments in 1979 on the population dynamics, crop damage, and control methods of *Acigona ignefusalis* [*Coniesta ignefusalis*] and midge species of pearl millet in Sefa–Maniora zone of Senegal are reported. Pearl millet was preferred to sorghum by the borer. Application of Furadan at 450 g a.i. ha⁻¹ gave satisfactory control.

180

Taneja, S.L., and Nwanze, K.F. 1989. Assessment of yield loss of sorghum and pearl millet due to stem borer damage. Page(s) 95–105 in International Workshop on Sorghum Stem Borers, 17–20 Nov 1987, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 6 ref.

Tiller infestation by *Coniesta ignefusalis* and internode damage were higher in the late-sown crop of pearl millet than in the early-sown crop in Niger. Insecticide protection under low borer damage resulted in a slight increase in grain

yield in the non-protected over the protected crop.

181

UCTR/PV (Unité de coordination technique régionale en protection des végétaux). 1991. [Workshop on Millet Yield Loss in Sahel: proceedings, 20–22 Mar 1991, Ouagadougou, Burkina Faso.]. Colloque sur le profil des pertes sur le mil dans le Sahel: comptes rendus, 20–22 mars 1991, Ouagadougou, Burkina Faso. (In Fr.). Ouagadougou, Burkina Faso: Institut du Sahel. 30 pp.

Methods for estimating crop losses developed by various projects in the Sahel are reviewed. A chemical control method that is used to evaluate millet crop losses due to *Coniesta ignefusalis* during the vegetative phase is described.

182

Uvah, I.I., and Ajayi, O. 1989. Chemicals for control of stem borers of pearl millet in the Nigerian savanna. Annual report, Entomology (millet, cowpea, groundnut). (Summary(s) in Fr.). Page(s) 16–22 in Proceedings of the Regional Pearl Millet Improvement Workshop, 4–7 Sep 1989, ICRISAT Sahelian Center, Sadore (Fussel, L.K., and Werder, J., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 10 ref.

Efficacies of some seed dressings and other chemical formulations for control of *Coniesta ignefusalis* were compared with that of granular carbofuran at Nigeria during 1985–88. Miral 3G at 15 kg granules ha⁻¹, Apronplus 500S seed dressing at 59 kg⁻¹ seed and Talstar 10 cc applied twice at 20 and 35 days after planting were found to be promising alternatives to carbofuran.

Other control methods

183

Bako, O. 1977. [Biological and ecological study of *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) for biological control.]. Etude biologique et écologique de *Haimbachia ignefusalis* (Hmps.) (Lepidoptera: Pyralidae, Crambinae) en vue d'une lutte biologique. (In Fr.). Thesis, Université Laval, Quebec, Canada. 61 pp.

Host plant–insect pest–parasitoid interactions of pearl millet and *Haimbachia ignefusalis* [*Coniesta ignefusalis*] were studied in Niger. Seven Hymenoptera parasites, three Diptera parasites,

and one fungus are listed. The potential of controlling this borer through crop residue destruction, use of sex pheromones, and natural enemies is discussed.

184

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1989. Pearl millet. Stem borer [*Coniesta (Acigona) ignefusalis*]. Page(s) 36-37 in Annual report 1988. Patancheru, A.P. 502 324, India: ICRISAT.

Sampling methods to estimate larval numbers, augmentation of natural populations and behavior patterns of *Coniesta ignefusalis* on pearl millet were studied at Niger. Larval exit holes gave a reliable estimate of larval populations. Uniform infestations were achieved by placing infested stems in test area and regulating the emergence pattern of adults. Active components of pheromones determined and seven trap designs were evaluated.

185

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Pearl Millet Improvement Program. Insect pests. Millet stem borer. Page(s) 11-12 in West African Programs annual report 1990. Niamey, Niger: ICRISAT Sahelian Center.

Identification and field-testing of the pheromone of *Coniesta ignefusalis* in Niger are reported. Five components of the pheromone were identified and tested in different combinations and mixture ratios for their ability to attract males.

186

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1992. Pearl Millet Improvement Program. Insect pests. Millet stem borer [*Coniesta (Acigona) ignefusalis*]. Page(s) 12-13 in West African Programs annual report 1991. Niamey, Niger: ICRISAT Sahelian Center.

Studies on optimization of pheromone blend for maximum attraction of male *Coniesta ignefusalis*, the efficiency and longevity of original and new polythene vial dispensers, and trap design parameters at Niger are reported.

187

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1993. Pearl Millet Improvement Program. Insect pests. Millet stem borer. Page(s) 11 in West African Programs an-

nual report 1992. Niamey, Niger: ICRISAT Sahelian Center.

Oviposition preference of *Coniesta ignefusalis* and pheromone trap parameters were studied at Niger. Of the five varieties tested, a trichomeless F³ progeny was significantly preferred for oviposition. The trap parameters for increased efficiency were established. Large dispensers were more efficient and lasted up to 42 days. Male moths were tolerant to E-isomers.

188

Lukefahr, M.J. 1989. Summary of 1988 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 27 pp. (Limited distribution.)

Results of studies on *Coniesta ignefusalis* on the biology, cultural control, pheromone traps, and crop loss assessment are presented.

189

Lukefahr, M.J. 1990. Summary of 1989 pearl millet entomology research activities. Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 23 pp. (Limited distribution.)

Results of studies on screening methodology and identification of resistance of pearl millet to *Coniesta ignefusalis* are presented. Information on the sex pheromone and trap design, bioecology, and crop loss assessment is also included.

190

Pierrard, G., and Ba, D. 1986. [Use of agrometeorology in controlling the insect pests of food crops in Sahel.]. Utilisation de l'agrométéorologie dans la lutte contre les ravageurs des plantes vivrières dans le Sahel. (In Fr.). Page(s) 71-80 in Comptes rendus du Colloque sur l'agroclimatologie, 8-12 décembre 1986, Bambey, Senegal. Bambey, Senegal: CIRAD (Centre de coopération internationale en recherche agronomique pour le développement), and IRAT (Institut de recherches agronomiques tropicales et des cultures vivrières).

An overview of Sahelian pests and their control methods is presented. An exhaustive agrometeorological study to understand the migratory patterns of *Acigona ignefusalis* [*Coniesta ignefusalis*] and to establish the relation between

first generation population size and that of later generations is suggested.

191

Youm, O., Beever, P.S., and Hall, D.R. 1993. Trap design studies with the pheromone of *Coniesta ignefusalis* (Hampson) (Lepidoptera: Pyralidae) in sub-Saharan Africa. IOBC WPRS Bulletin [Bulletin OILB SROP] 16(10): 58-63. 8 ref. [Presented at the IOBC/WPRS Working Group Meeting on the Use of Pheromones and other Semiochemicals in Integrated Control, 11-14 May 1993, Chatham, UK.].

A water-oil based trap developed from local material proved to be three-fold as efficient as one commercial trap. Implications on trap designs and optimization studies for monitoring *Coniesta ignefusalis* are discussed.

Integrated pest management

192

Ajayi, O. 1990. Possibilities for integrated control of the millet stem borer, *Acigona ignefusalis* Hampson (Lepidoptera: Pyralidae) in Nigeria. (Summary(s) in Fr.). Insect Science and its Application 11(2): 109-117. 13 ref.

Various control options for *Acigona ignefusalis* [*Coniesta ignefusalis*] including date of planting, fertilization, chemical insecticides, and biological control are presented and the possibilities of integrating them for stem borer management are discussed.

193

Dakouo, D., and Lankoande, A. 1992. [Lepidopterous stem borers on sorghum: seasonal variation, economic importance and prospect for integrated pest management.]. Les lépidoptères foreurs de tige du sorgho: fluctuations saisonnières, importance économique et perspectives de lutte intégrée. (In Fr.). Page(s) 102-109 in La lutte intégrée contre les ennemis des cultures vivrières dans le Sahel: Deuxième séminaire sur la lutte intégrée contre les ennemis des cultures vivrières dans le Sahel, 4-9 Jan 1990, Bamako, Mali. Montrouge, France: John Libbey Eurotext.

Acigona ignefusalis [*Coniesta ignefusalis*] was predominant on sorghum in Burkina Faso in wet region (700-1400 m). Seasonal variation, eco-

nomie importance and prospects for integrated management of borers are discussed.

194

FAO. 1987. [Research and development of the integrated control of the enemies of the main food crops in the Sahel countries: summary of activities (1981-86) and recommendations, Biological Control Program, CILSS Project for Integrated Control, Senegal. Report based on the work of V.S. Bhatnagar.]. Recherche et développement de la lutte intégrée contre les ennemis des principales cultures vivrières dans les pays du Sahel: synthèse des activités (1981-86) et recommandations, programme de lutte biologique, Projet CILSS de lutte intégrée, Senegal. Rapport établi sur la base des travaux de V.S. Bhatnagar. (In Fr. Summary(s) in En.). Rapport Technique GCP/RAF/128/CLS. Rome, Italy: FAO.

Results of the observations on pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] are briefly presented.

195

Gahukar, R.T., Bos, W.S., Bhatnagar, V.S., Dieme, E., Bal, A.B., and Fytizas, E. 1986. [Recent findings in millet entomology in Senegal: presented at the Evaluation Meeting of Millet Programme, 19-21 Mar 1986.]. Acquis récents en entomologie du mil au Sénégal: document présenté à la Réunion d'Évaluation du Programme Mil, 19-21 mars 1986. (In Fr.). Bambey, Senegal: Institut sénégalais de recherches agricoles.

Research results on integrated pest management of insect pests of pearl millet including *Acigona ignefusalis* [*Coniesta ignefusalis*] in Senegal are reported. 69-72 per cent of larvae of *Acigona* were found on pearl millet stems. Partial burning of stems after harvest resulted in 61-84 per cent larval mortality and 98-100 per cent pupal mortality.

196

Jago, N.D. 1990. Economically viable chemical pest control of millet pests at farmer level in Sahelian Mali. Page(s) 87-92 in Proceedings: Integrated Pest Management in Tropical and Subtropical Cropping Systems 89, 8-15 Feb 1989, Bad Dürkheim, Federal Republic of Germany. Vol. 1. Frankfurt, Federal Republic of Germany: Deutsche Landwirtschafts-Gesellschaft.

During 1985–88, integrated control of millet pests including *Acigona ignefusalis* [*Coniesta ignefusalis*] was studied in Mali. Use of local rock phosphate, introduction of resistant varieties and ULV application of insecticides were considered.

197

Maiga, S.D. 1984. [Insects of cereals.]. Insectes des céréales. (In Fr.). Page(s) 2–21 in Premier séminaire régional de formation, Projet amélioration des mils, sorgho, niébé et maïs: Entomologie, 18 Apr – 2 May 1984, Maradi and Tarna. Maradi, Niger: INRAN (Institut national de recherches agronomiques du Niger).

The principal pests of millet, including *Haimbachia ignefusalis* [*Coniesta ignefusalis*] in the Sahel are covered. Their morphology, geographical distribution, damage, and periods of activity are reported. Integrated pest management strategies are briefly discussed.

198

Mamalo, A.K. 1990. [Prospects for integrated control of *Coniesta (Acigona) ignefusalis* Hampson (Lepidoptera: Pyralidae, Crambinae) the millet stem borer.]. Perspectives pour une approche intégrée de lutte contre *Coniesta (Acigona) ignefusalis* Hampson (Lepidoptera: Pyralidae, Crambinae) borer de tige du mil en zone sahélienne. (In Fr.). Thesis, Université de Ouagadougou, Ouagadougou, Burkina Faso. 116 pp.

The insect-plant environment and existing methods of pest control in the ecological context of Sahel are reported. Sex pheromones, varietal resistance, effect of chemical fertilizers, and crop residue management as means of effective control are discussed and a multidisciplinary integrated pest control strategy is recommended.

199

Nwanze, K.F. (No date.). Stem-borers of cereals in Sahelian West Africa: relative importance and control. Page(s) 115–123 in Biological control of pests: its potential in West Africa: proceedings of an International Conference, 9–13 Feb 1981, Dakar, Senegal. Dakar, Senegal: US Agency for International Development Regional Food Crop Protection Project. 14 ref. [Also issued in Fr.: Pages 108–115 in Lutte biologique contre les ravageurs et ses possibilités en Afrique de l'Ouest: compte rendu du séminaire qui a eu lieu, 9–13 Fev 1981, Dakar, Senegal.].

Acigona ignefusalis [*Coniesta ignefusalis*] is the predominant borer on millet and is more widely distributed in the Sahel than *Busseola fusca*. It is more prevalent in the North, than in the South on sorghum. Various cultural measures, use of resistant varieties, and release of biological control agents, are reviewed in the context of integrated pest management.

200

Nwanze, K.F. 1985. Some aspects of pest management and host plant resistance in pearl millet in the Sahel. (Summary(s) in Fr.). Insect Science and its Application 6(3): 461–465. 19 ref.

The relative importance and significance of host plant resistance in an integrated pest management program is compared against other modalities. Natural enemies appear inefficient in controlling *Acigona ignefusalis* [*Coniesta ignefusalis*].

201

Nwanze, K.F., and Mueller, R.A.E. 1989. Management options for sorghum stem borers for farmers in the semi-arid tropics. (Summary(s) in Fr.). Page(s) 105–116 in International Workshop on Sorghum Stem Borers, 17–20 Nov 1987, ICRI-SAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 33 ref.

Existing control measures against sorghum stem borers including *Acigona ignefusalis* [*Coniesta ignefusalis*] are briefly reviewed. The review indicates that most recommendations are impractical and have not been adopted by farmers in the SAT. A farming systems perspective to stem borer management is stressed.

202

Sagnia, S.B. 1983. Possible integrated pest management tools for the effective control of cereal stem borers in the Gambia. Insect Science and its Application 4(1–2): 217–219. 5 ref.

Stem borer infestations of millet by *Acigona ignefusalis* [*Coniesta ignefusalis*] and *Sesamia nonagrioides botanephaga* can reach 35 per cent. Commonly used insecticides for their control are given. Integration of control methods and constraints are discussed.

203

Youm, O., Mamalo, A.K., and Nwanze, K.F. 1993. Bio-ecology and integrated management of

the millet stem borer (Lepidoptera:Pyralidae): a review and highlights of current research at the ICRISAT Sahelian Center. (Summary(s) in Fr.). Page(s) 55-63 in Proceedings of the Regional Pearl Millet Workshop, 19-21 Sep 1990, Niamey, Niger (Youm, O., and Kumar, K.A., eds.). Niamey, Niger: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Center. 36 ref.

Literature on *Coniesta ignefusalis* is reviewed. Priorities of research at the ICRISAT Sahelian Center include estimation of yield losses, biology as related to laboratory culturing, development of screening techniques, development of effective cultural control methods, identification of borer resistant lines, and search for effective natural enemies.

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Directory of Institutions and Researchers

This provisional listing of organizations and scientists working on *Coniesta ignefusalis* is based on recent publications and personal contacts. We welcome comments and additions so that a comprehensive up-to-date directory can be maintained at ICRISAT.

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About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.



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