RECENT DEVELOPMENTS IN THE CONTROL OF *IDAECAMENTA EUGENIAE* (COLEOPTERA: SCARABAEIDAE: MELOLONTHINAE) AT KINYARA SUGAR WORKS LTD, UGANDA

MUGALULA A[1], TIBAKANYA G[1] and CONLONG D E[2,3]

[1]*Kinyara Sugar Works, Masindi, Uganda*
[2]*South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe, 4300, South Africa*
[3]*School of Biological and Conservation Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg, 3201*
MugalulaA@Kinyara.co.ug TibakanyaG@Kinyara.co.ug Des.Conlong@sugar.org.za

Abstract

The presence of white grub infesting sugarcane at Kinyara Sugar Works Ltd (KSWL) in Uganda was first noticed in December 2001. The species was identified in 2002 by the Natural History Museum in London as *Idaecamenta eugeniae* Arrow. This was the first time *I. eugeniae* had been recorded from sugarcane.

This paper documents the adult flight patterns, the life cycle and the spread of *I. eugeniae* on the estate from 2003 to 2005. Results from cultural and insecticidal control treatments of infected fields, which lowered levels of the pest to less than two larvae per pit, are presented.

Keywords: white grub, Uganda, pest surveys, cultural control, chemical control

Introduction

African sugar producing areas have generally been free of severe white grub (Coleoptera: Scarabaeidae) infestation. Exceptions have been the Swaziland and Zimbabwean sugar industries, which were heavily infested with *Heteronychus licas* Klug (Coleoptera: Scarabaeidae: Dynastinae) (Carnegie, 1988; Rajabalee, 1994), and an estate in Tanzania, which was severely affected by *Cochliotis melolonthoides* Gerst (Coleoptera: Scarabaeidae: Melolonthinae) (Rajabalee, 1994; Evans *et al*, 1999). In 2004, a localised occurrence of a yet to be identified white grub species was observed in sugarcane in Nzoia, Kenya (Mutonyi, 2004).

White grub damage in sugarcane fields was confirmed at Kinyara Sugar Works Ltd (KSWL), Uganda, in 2001. Investigations showed large numbers of white grubs under cane stools in the Kiryatete section. In June 2002, the Natural History Museum in London identified this species as *Idaecamenta eugeniae* Arrow (Coleoptera: Scarabaeidae: Melolonthinae) (Conlong and Mugalula, 2003). Initial investigations showed that cultural control through ploughing and harrowing badly infested fields reduced grub numbers significantly, and that certain insecticides had no effect on grub numbers at that time (Conlong and Mugalula, 2003).

The insecticide trial conducted in 2002 and reported on by Conlong and Mugalula (2003) was set down in an infected field (Kingo 8) using the insecticides Confidor (active ingredient imidacloprid, 200 g /L SC), Dursban (active ingredient chlorpyriphos, 480 g/L EC) and Pyrinex (active ingredient chlorpyriphos). No impact of the insecticides on grub populations was recorded.

This paper updates the data presented by Conlong and Mugalula (2003) on adult flight patterns and the life cycle. It further documents the spread of *I. eugeniae* on the estate from 2003 to 2005. In addition, the occurrence of natural enemies and results from cultural and insecticidal control treatments implemented during this period in infected fields are presented.

Materials and Methods

Surveys

Estate-wide surveys for white grubs

Ten standard sized pits measuring 30 x 30 x 30 cm were dug at random, but always in the cane row, in selected fields of all sections on the estate. Soil and root material was carefully searched for any life stage of grub and/or natural enemy. All pupal and larval specimens were collected from the pits and recorded. Adults were found in the top layers of soil. These were also recorded. The egg stage was not recorded due to the difficulty of identification. The surveys were carried out from January to December 2003.

The mean number of life stages per field was determined from these pits. A 100% survey intensity of the estate was conducted in 2003 and 15% in 2004.

Seasonal population fluctuation

The KSWL Agronomy Section completed monthly surveys in selected heavily infested fields of the estate using the above standard sized pits. Ten pits were dug and inspected per field, as described above. 14 fields which were highly infested by white grub were monitored on a weekly basis during the year 2003. The mean number of larvae, pupae and adults found in the pits at each sampling date was determined.

Insect light trap observations

From 2003 to 2005 daily counting of adult *I. eugeniae* beetles caught in a Robinson-type light trap placed at KSWL estate, was used to determine flight patterns. This information was used in determining the flight peaks of the beetles.

Control measures

Indigenous biological control agents

While searching through soil and cane roots dug from pits, care was taken to find any dead or ‘sick’ looking *I. eugeniae* immatures. Pathogens have previously been collected from infected *I. eugeniae* grubs (Conlong and Mugalula, 2003). Any other organisms attacking the immature stages were also collected.

Insecticide trials

An second insecticide trial was conducted in 2004 in a heavily infested field at Kingo 19. Confidor and Dursban were used, in addition to Diazol (a.i. diazinon, 60 g/L EC), Actara 25 g/L (a.i. thiamethoxam) and SuSCon Marshall (a.i. carbosulfan 100g/kg). The rates applied are given in Table 1.

Table 1. Chemical products used in Kingo 19 trials.

Product	Product rate per ha	Active ingredient	Rate (kg a.i/ha)
Actara 25 g/kg WG	400 g	thiamethoxam	0.1
Diazol 60 g/L EC	1.5 L	diazinon	0.9
Confidor 200 g/L EC	2.6 L	imidaclorpid	0.52
Dursban 480 g/L EC	2.6 L	chlorpyrifos	0.9
SuSCon Marshall 100 g/kg G	20 kg	carbosulfan	0.02

The plot size was 3 rows x 1.5 metre interrow x 300 metre length, with 3 replications.

The method of application involved applying the insecticides after harvest, in furrows dug 50 cm apart, and to a depth of 12.5 cm, on either side of the cane row. All the insecticides, apart from SuSCon Marshall, were applied in 150 litres of water using knapsack sprayers. The furrows were covered with soil immediately after application of the insecticide. SuSCon Marshall granules were applied by hand in the furrows. Ten pits were dug in each treatment, and the numbers of immature stages of *I. eugeniae* found per pit were counted (Conlong and Mugalula, 2003).

Cultural control

A trial was established in 2004 in Rukukura Section (Field 12) to establish the number of plough runs required to reduce white grub populations below the economic threshold (three grubs per pit) in badly infested fields in Kinyara. The field was surveyed for white grubs before the establishment of the trial and found to have up to 6.5 grubs/pit.

The plot size was 20 metres x 264 metres (0.49 ha). The first ploughing was done in September 2003, three weeks after spraying the field with Touchdown for stool eradication. Ploughing was carried out using a Rome plough, at a depth of approximately 25 cm.

The trial design was RCB with four replications. The treatments and layout are shown below.

Treatments:

A = Normal practice - one plough and one harrow
B = Two ploughs and one harrow
C = Three ploughs and one harrow.

Monthly surveys were carried out in the 12 plots. Twenty pits were dug in each treatment and *I. eugeniae* immature stages were collected.

Results and Discussion

Life stages of white grubs

As shown in the preliminary study by Conlong and Mugalula (2003), the larval stage was the most predominant during the year. Subsequent surveys reflect what was reported by Conlong and Mugalula (2003). Figure 1 shows the mean proportion of larvae, pupa and adults found in the pits at each sampling date in 2003. Grub (larval) populations increased steadily from 0.2 grubs/pit in April to 1.5 grubs/pit in November. The pupae were observed between January and May, with a peak (0.1 pupa/pit) in February 2003. Adults were observed

between February and June, with the peak recorded (0.4 adults/pit) in March (Figure1). By April 2003, adults constituted at least 50% of the total grub life stages observed (Figure 1). The low mean grubs per pit from April to July could be an underestimate, as the egg and early larval stages are difficult to observe because of their small size.

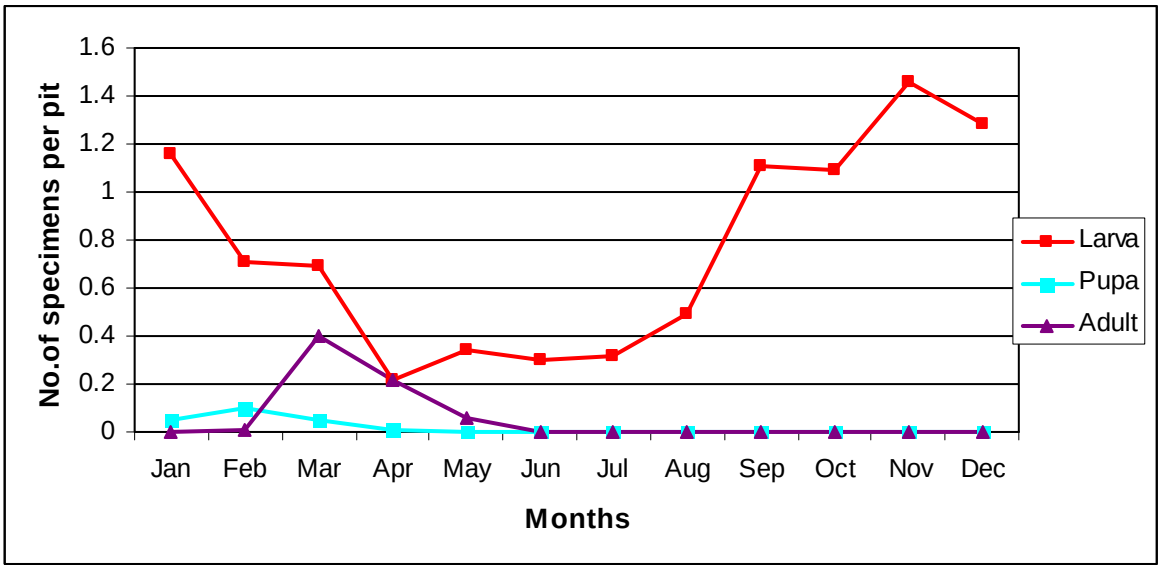

Figure1. Structure of the *Idaecamenta eugeniae* Arrow (Coleoptera: Scarabaeidae: Melolonthinae) population at Kinyara Sugar Works Ltd, Uganda, in 2003.

Extent of infestation on the estate

At least 12 out of 19 sections (63.1%) had white grub infestations. In 2003, Rukukura (0.3 grubs/pit) and Kingo (0.35 grubs/pit) had the highest infestations (Figure 2).

All fields sampled in Kingo section had grubs. Despite grubs being more widespread through Rukukura section than Musoma section, the latter had grubs present in 80% of the fields surveyed, while in Rukukura only 26% were infested (Figure 3).

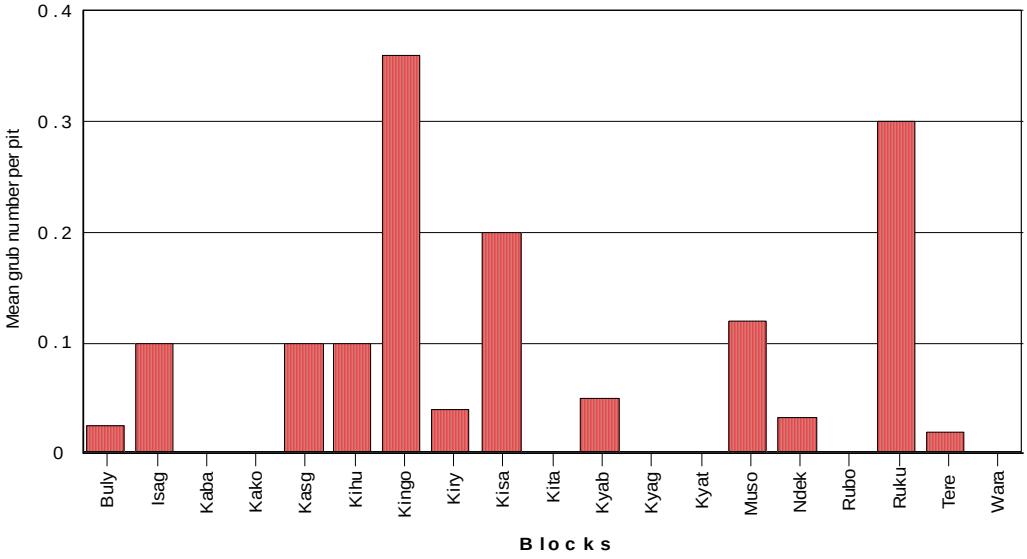

Figure 2. Mean number of grubs found per pit in fields surveyed for *Idaecamenta eugeniae* Arrow (Coleoptera: Scarabaeidae: Melolonthinae) in the different sections of Kinyara Sugar Works Ltd, Uganda.

Even though the estate-wide surveys reported here were at different times of the year to those completed by Conlong and Mugalula (2003), current white grub populations were less widespread. Conlong and Mugalula (2003) recorded white grub infestations in 14 of the 16 sections surveyed (87.5%), compared to only 63.1% of the sections reported in the survey. Populations of grubs per pit were also substantially lower. In December 2002, the pits in fields at Kingo section had a mean of 30/pit, at Kyabagenyi 7/pit, at Isagara 4 and at Musoma 2 (Conlong and Mugalula, 2003). Figure 2 show a maximum mean populations per pit of 0.35 at Kingo. Although the surveys were conducted in April 2003, when adults were flying (Figure 3), and a reduction in grub numbers could be expected, a reduction from 30 to 0.35 per pit was substantial. Future estate-wide surveys should always be undertaken in November/December, when grubs are most common.

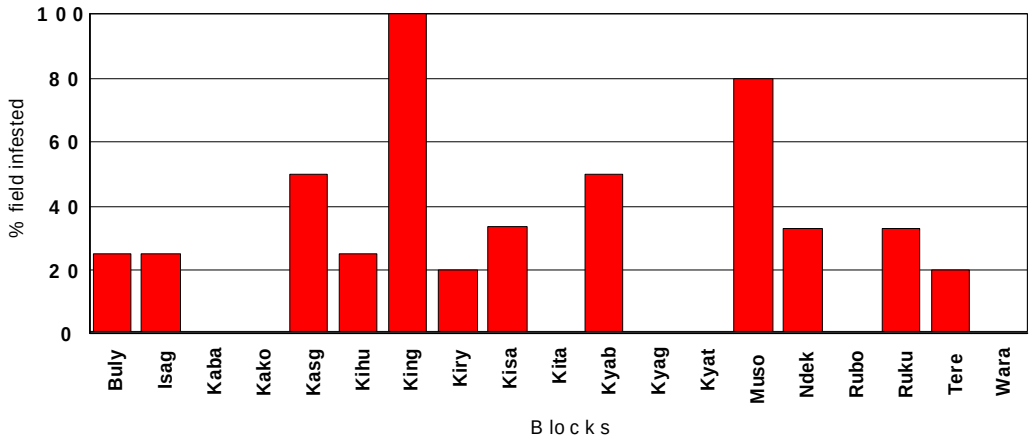

Figure 3: The percentage of fields in each section of Kinyara Sugar Works Ltd with life stages of *Idaecamenta eugeniae* Arrow (Coleoptera: Scarabaeidae: Melolonthinae) present.

Adult flight patterns

Similar to results by Conlong and Mugalula (2003), Figure 1 shows that adult flights occur between January and June, with a peak in March/April. Figure 4 shows that during these years the flight period remained the same, but that numbers of adults caught in the trap decreased from 1200 in April of 2003, to 50 in April 2005.

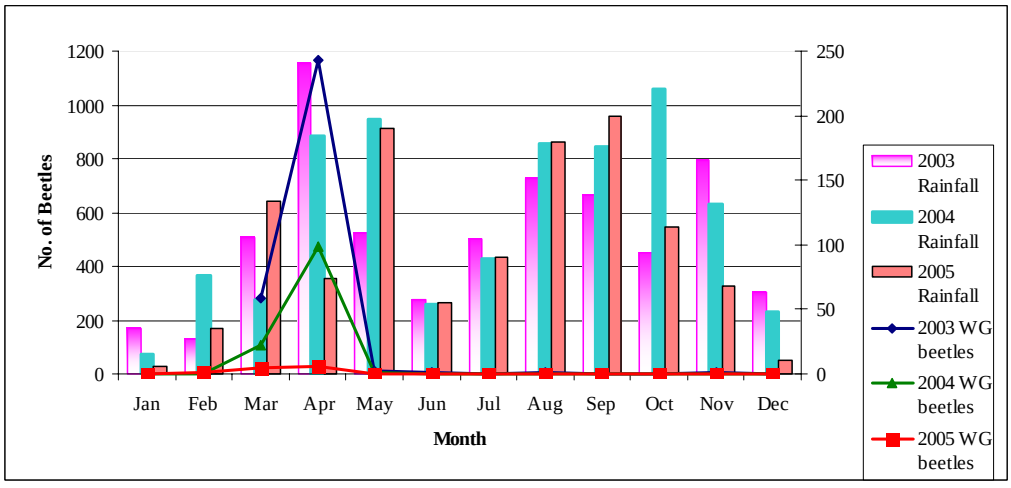

Figure 4. *Idaecamenta eugeniae* Arrow (Coleoptera: Scarabaeidae: Melolonthinae) adult flight patterns from 2003 to 2005, related to monthly rainfall recorded at Kinyara Sugar Works Ltd for the same period.

Considering the rainfall in April 2003 through 2005 (Figure 4), 240 mm was recorded in April 2003, about 180 mm in April 2004, and close to 75 mm in April 2005, a drastic reduction over the three years. There is a strong relationship existing between adult flight and rainfall received, with more adults flying when there is increased rainfall. (Figure 4). However, frequent control interventions recommended by Conlong and Mugalula (2003) and conducted by KSWL staff since then may also have contributed to the reduction in numbers of subsequent generations.

Control measures

Insecticide trials

As was found in the first trial (Conlong and Mugalula 2003), there was no significant difference between the mean grub numbers per pit observed in all treatments, with each maintaining the grub level below the economic injury level, i.e. 2 grubs/pit, in the more recent trial (Table 2). Dursban and Actara had short-lived beneficial effects, but at the end of 28 weeks the treatments were not significantly different to the control.

Table 2. Results of chemical control of *Idaecamenta eugeniae* Arrow (Coleoptera: Scarabaeidae: Melolonthinae) in an insecticide trial at Kingo 19 field of Kinyara Sugar Works Ltd.

Weeks after treatment application	Mean grubs/pit							
	Wk 4	Wk 8	Wk 12	Wk 16	Wk 20	Wk 24	Wk 28	Mean
Control	0.13	0.03	0.16	0.06	0.10	0.03	0.03	0.08
Actara	0.03	0.03	0.06	0.10	0.03	0.00	0.13	0.05
Diazol	0.06	0.06	0.13	0.13	0.03	0.03	0.13	0.08
Confidor	0.10	0.03	0.10	0.13	0.00	0.00	0.03	0.06
Dursban	0.03	0.03	0.03	0.06	0.00	0.00	0.03	0.03
SuSCon Marshall	0.43	0.00	0.06	0.00	0.00	0.00	0.00	0.07
Means	0.13	0.03	0.08	0.08	0.01	0.01	0.06	0.06
Significance								ns
SE								0.04
CV%								118.8

Note: the mean excludes the control mean.

SuSCon Marshall is a slow release insecticide and showed some prolonged residual activity.

Biological agents

Five specimens of *I. eugeniae* larvae killed by the entomogenous fungus Metarrhizium anisopliae were found in some of the pits examined during 2001 to 2005. Populations of these natural enemies could be augmented to provide more effective control.

Mechanical control

The extensive ploughing treatment (two ploughs and two harrows) of the fields badly infected by *I. eugeniae* in December 2001 (Kiryatete 20 and 22) reduced grub numbers from a mean of 9 to less than 1 per pit in field 20, and from 11.5 to less than 1 per pit in field 22 (Conlong and Mugalula, 2003). In 2003, Kiryatete 16 had a mean grub population per pit of

3.4 during the fallow period. This was reduced to less than one grub per pit after ploughing. Similarly, a trial was set up in Rukukura 12 to determine the number of plough runs that can effectively control grub population. Results are given in Figure 5. The mean grub population per pit was reduced to less than one per pit after repeated ploughing. The initial population was 6.5 grubs per pit and this was reduced to 0.2 in the one plough + one harrow treatment. In the three ploughs + one harrow treatment the population was reduced to 0.1 grubs per pit. Two ploughs + one harrow gave adequate control of white grubs and was economically viable. This treatment is recommended for heavily infested fields (more than 3 grubs per pit).

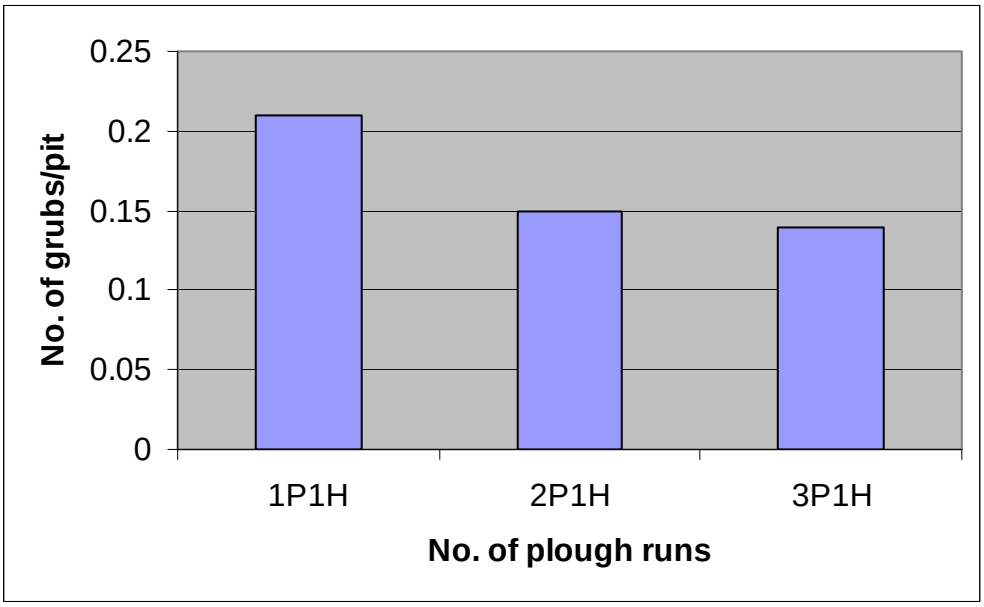

Figure 5. Number of grubs/pit under different ploughing and harrowing regimes to control *Idaecamenta eugeniae* Arrow (Coleoptera: Scarabaeidae: Melolonthinae) grubs in the soil of an infested field at Kinyara Sugar Works Ltd (P=plough; H=harrow).

Conclusions

Grub infestation levels recorded through field surveys and the use of light traps revealed a significant reduction in the population of grub life stages over a period of three years. Field survey results indicate a 99.8% decline in the number of grubs per pit recorded from December 2002 to December 2005. The light trap results reflected a similar fall (96.4%) in the number of flying adults. This can be attributed to the cultural control intervention, especially the repeated plough runs and harrowing. Analysis of the grub life cycle shows that the initial recommendations of Conlong and Mugalula (2003) still stand, in that grub control programmes should always be planned during the dry season from November to January, during the pre-pupal stages when the fields are fairly dry, so allowing the desiccation of immature stages.

Minimum tillage should be restricted to areas with no grubs at all. Two ploughs and one harrow operations should be carried out where there is high infestation. In the event of severe grub outbreak, SuSCon Marshall could be used. However, insecticide trials completed so far are not encouraging. It is premature to consider large-scale insecticide applications because of the generally very low populations of *I. eugeniae* present on the estate. In addition, it cannot be predicted where the high infestations of this white grub will occur, a necessary requirement for the application of insecticide trials.

To contribute to the knowledge of the biology of this pest in sugarcane at KSWL, routine soil sampling will be continued in selected fields to confirm life stages presence. Light traps will also be kept operational to accurately monitor adult flight times and patterns. There is also a need to determine life table parameters such as female fecundity, length of the different life stages, and presence in different habitats, which could form part of postgraduate studies on the estate.

REFERENCES

Carnegie AJM (1988). White grubs (Scarabaeidae) continue to cause sporadic damage to sugarcane in South Africa and Swaziland. *Proc S Afr Sug Technol Ass* 62: 161-163.

Conlong DE and Mugalula AM (2003). *Idaecamenta eugeniae* (Coleoptera: Scarabaeidae: Melolonthinae): A new species of white grub in Ugandan sugarcane. *Proc S Afr Sug Technol Ass* 77: 250-255.

Evans HC, Smith SS, Katundu JM and Kapama JT (1999). A *Cordyceps* pathogen of sugar-cane white grubs in Tanzania. *Mycologist* 13: 11-14.

Mutonyi J (2004). White cane grubs: A potential pest challenge to the sugar industry in Kenya. *Proc S Afr Sug Technol Ass* 78: 549.

Rajabalee A (1994). Pest status, biology and control measures for soil pests of sugarcane (including nematodes) in Africa and close islands. pp 1-11 In: AJM Carnegie and DE Conlong (Eds), *Biology, Pest Status and Control Measure Relationships of Sugar Cane Insect Pests.* Proceedings of the Second ISSCT Sugar Cane Entomology Workshop. 30 May-3 June, Mount Edgecombe, KwaZulu-Natal, South Africa. ISBN 1-874903-10-7. 255.