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Aspects of Biological Control of the Citrus Woolly White Fly, Aleurothrixus floccosus in Eastern Uganda

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Abstract

A biological control agent, *Cales noackii* How– the natural enemy of citrus woolly white fly, *Aleurothrixus floccosus* Mask was introduced in Uganda for the control of the pest in two citrus growing districts (Iganga and Kamuli) of eastern Uganda in 1996. Prior to the introduction, surveys conducted throughout the country showed that the pest causes serious damage to citrus growing especially along the Lake Victoria crescent. Of the surveyed area, 95% of the citrus trees sampled showed damages attributed to the pest. However, post natural enemy release monitoring during 1996 – 1998 in the two study districts of Iganga and Kamuli showed that *A. floccosus* population and damage had significantly declined. The pest population and damage reduction was attributed to the establishment and impact of *C. noackii*; and by 2000 the pest population was insignificant as the natural enemy spread to non-release areas.

Keywords: Citrus woolly whitefly, biological control, Aleurothrixus floccosus, Cales noackii

Introduction

Citrus is a crop of relative importance in Uganda as it is grown for both domestic fruit supply and cash (Ocen – Ayer et al, 1995). it is grown under small-scale farm holding though prior to political instability in the 1970's, there were large government farms producing citrus for industrial use and export. Uganda, however, does not rank as an important citrus producer in Africa (Table 1). Apart from poor agronomic practice like irregular weeding, the crop is severely affected by several pests and diseases among which the Citrus Woolly Whitefly (CWWF) ranks as the most important pest in Uganda (Ocen – Ayer et al, 1995).

Citrus woolly white fly originates from a sub tropical area that stretches from the Caribbean, South America, Mexico to Florida (De Bach, 1970). The pest probably entered Africa through the citrus growing belt of the Mediterranean region. It was first reported in Morocco in 1975. Morocco is one of the twenty African countries that commercially produce citrus for export (Seif personal communication). From the Mediterranean, the pest spread to other parts of the continent.In East Africa, it was first recorded in Kenya and Tanzania in 1992 (Nyambo, personal communication). In Uganda, the precise time of the pest outbreak is not known though surveys conducted in Iganga and Kamuli in eastern and Masaka in the southwest Uganda showed extensive incidence and damage by the pest in the lake crescent region (Ocen – Ayer, et al, 1995).

Citrus Woolly White Fly (CWWF) sucks sap from young citrus leaves. Symptoms include cotton - like wool under leaf surface that harbours the nymphs. The nymphs secrete honeydew, which is a substrate for moulds that cover the affected leaf surface with as a sooty black mould. Apart from harbouring fungal pathogens, the black coating interfere with normal photosynthesis and reduces productivity of an affected crop. The pest has a wide range of potential hosts including avocado and other trees.

In nature, several natural enemies that evolved with CWWF are known (DeBach, 1970). Among the most promising natural enemies are, *Amitus spiniferous* Brethes (Hymenoptera:Platygasteridae) and *Cales noackii* (Hymenoptera:Aphlenidae). They have successfully been

Table 1 Citrus production and trade in some countries in Africa

Country	Production (000 MT)	Exports		Imports	
		MT	(US$000)	MT	(US$000)
Algeria	284	313	138	-	-
Angola	80	N/A	N/A	N/A	N/A
Cameroon	N/A	171	78	546	175
Central African Rep.	18	N/A	N/A	-	-
Cote d'Ivoire	58	-	-	550	420
Egypt	1753	161537	160683	784	456
Ethiopia	26	-	-	N/A	N/A
Ghana	64	-	-	N/A	N/A
Kenya	67	329	293	-	-
Libya	105	-	-	N/A	N/A
Madagascar	99	7	3	-	-
Morocco	1450	610,000	160,250	-	-
Mozambique	43	16000	5280	-	-
Somalia	44	-	-	N/A	N/A
South Africa	621	415000	160500	400	150
Sudan	133	-	-	N/A	N/A
Swaziland	79	37000	15140	-	-
Tunisia	262	40471	14076	-	-
Zaire	172	-	-	N/A	N/A
Zambia	4	-	-	N/A	N/A
Zimbabwe	53	14950	2620	-	-

Source: *FAO Yearbooks (1989):*
1. Production, Statistic Series, No. 94, Vol. 43: 214-216
2. Trade, Statistic Series, No. 96, Vol. 43: 155-157

MT, Metric tons; N/N information not available - , no trade recorded

used to control citrus woolly whitefly in several countries (Onillon, 1970; Viggiaani and Mazzone, 1982 , Longo et al 1985).

Biological control of CWWF in Uganda was initiated in 1996 using *C. noackii* as a follow up of country wide survey conducted in 1995 to map out the areas affected and establish pest intensity (Ocen-Ayer, 1995). Results from the survey indicated that CWWF was a pest that was spreading and causing substantial damage throughout Uganda, especially in the east. In preparation for the importation of *C. noackii* into Uganda, a mass rearing facility for CWWF and *C. noackii* was set up through the establishment of a citrus nursery in a screen house at Namulonge Agricultural and Animal Production Research Institute. When an established colony of CWWF was set up, two consignments of *C. noackii* were imported from Switzerland (Table 2).

Materials and Methods

Release and monitoring C. noackii in eastern Uganda

Table 2. Consignment of Cales noackii from Switzerland

Origin	Date	Number shipped	% mortality	Number released
California	1994	300	38.7	184
Italy	1994	300	23.3	230
Italy	1994	1,500	24.1	1,138

Release

After the initial introduction of *C. noackii* to CWWF infested citrus seedlings enclosed in glass cages, the first adult *C. noackii* parasitoids emerged after two weeks. When the parasitoid population built up to significant level, the adult parasitoids were collected into vials using aspirators after which they were stabilized in the laboratory by feeding them on 1% sugar solution soaked into cotton wool plugs.

The acclimatized parasitoids in vials were then transported in a cool box to areas of release where a quick sample and examination was made on selected citrus plants to determine the base population of CWWF. Only citrus plants that were tender but mature and with adequate CWWF population were selected. The parasitoids were released in the districts of Mpigi,Kamuli and Iganga by positioning oneself in the middle of the citrus plants and opening the vials to allow the parasitoids to escape and locate their hosts freely. Releases were made in December 1996 in the three districts.

Monitoring

Monitoring for *C. noackii* were carried out by sampling selected citrus trees in one field each in Lwangosa and Bwiza parishes of Iganga and Kamuli districts respectively. These parishes were selected because of the high population of citrus woolly whitefly (in Iganga 88% of the plants were infested and 92% in Kamuli), and extensive citrus crop grown in the areas.

During sampling, each selected tree was divided into four quadrants representing north, south, east and west compass directions. In each quadrant, 4 upper leaves of

new flushes were selected and the number of adults, eggs and nymphs of citrus woolly whitefly was estimated from the selected sample plants. The number of adults was estimated by accounting and the damage was estimated on a 1-5 score scale while the eggs and nymphs were estimated as a percentage of each leaf surface covered and scored on a 1-4 scale. Incidence of sooty mould on the leaves was observed and scored using a 1-3 scale.

The abundance of the parasitoids was assessed during sampling by collecting citrus leaves infested with 2nd–4th instars of the citrus woolly whitefly and bagging them. The paper bags with the samples were later transported to the laboratory and the number of emerged adult *C. noackii* was counted and recorded daily till no further emergence was noted.

Results

The number of adult *C. noackii* released per location per district is shown in Table 3. Releases were made in Mpigi, Iganga and Kamuli all in the subhumid areas of Uganda. Population dynamics of both the citrus woolly whitefly and *C. noackii* at the two monitoring sites in Iganga and Kamuli during the years 1996/98 are shown in Figs1 and 2. In Lwangosa, Iganga district, adult infestation level of CWWF and nymphs was highest in the months of February and October as shown by the mean adult score. The mean CWWF egg level was highest one in March. The mean adult and egg numbers in Bwiza, Kamuli followed a similar trend as for Lwangosa, with the highest mean CWWF adult and nymphs numbers in February and May.

The mean number of adult *C. noackii* in relation to the CWWF population is shown in Fig. 1 and 2. The parasitoid population in Lwangosa built up to 34.2adults/10 leaves/tree in June with a peak of 83.6 adults/10leaves/tree in December during the two years. In Bwiza, Kamuli district, *C. noackii* mean population built up to a peak of 49.3adults/10 leaves/tree in November. There were noticeable decrease in CWWF infestation and damage scores as a result of the establishment and build up of the natural enemy population

One important factor noted during post release monitoring for the *C. noackii* populations was the fast rate of spread of the parasitoid in Uganda. By end of 1997 the parasitoid population had radiated to cover over 50 km from the original points of release especially in Iganga and Kamuli in eastern Uganda (Table 4).

Table 3.Cales noackii releases in Uganda, 1996 – 1998

District (County)	Date	Number ofRelease trees	Number of C. *noackii* released	Status
IGANGA				
Kigulu	1996	22	812	Established
Bukooli	1996	13	2552	"
Luuka	1996	22	1200	"
Busiki	1996	89	1200	"
KAMULI				
Bugabula	1996	56	2800	"
Buzaaya	1996	15	750	"
Mbulamiti	1996	40	4200	"
MPIGI				
Kyadondo	1996	15		
Mawokota	1996	40	985	"
		3700		"

Fig.1. chnages in adult CWWF numbers and include of noacki at Lwangosa during 1996 - 1998

Fig. 1. Changes in adult CWWF numbers and incidence of C. noacki at Lwangosa during 1996 - 1998

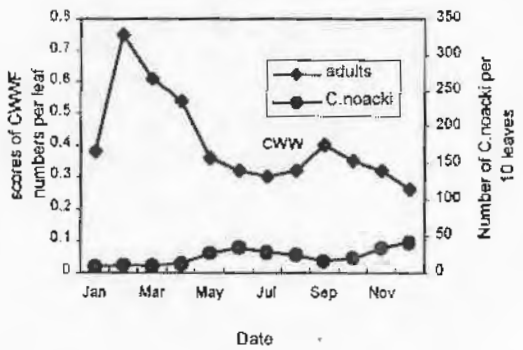
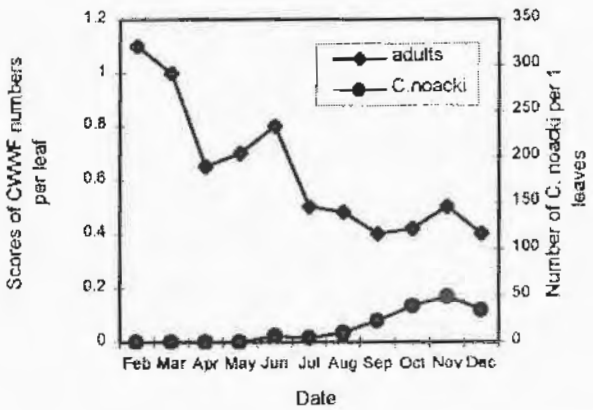


Table 4 Spread of C. noackii from original points of release to non-release sites in 1997 in Busiki Iganga District

Location	Distance From Release point (km)	Number of trees sampled Recovered	Mean No. of *C. noackii* Reco-vered	Mean No. of *CWF* adults	Mean No. of *nymphs* scored per leaf
Buwongo	0	2	102	2	
Nambale	10	2	31.6	0.9	2
Kasodo	20	4	12	0.4	0.3
Kaiti	15	3	10.5	1.2	0.4
Nabikabala	30	5	72.0	0.7	

Fig. 2 changes in adult CWWF numbers and incidence of C. noacki at Bwiza during 1996-98

Fig. 2. Changes in adult CWWF numbers and incidence of C. noacki at Bwiza during 1996-98



Discussions

Biological control of CWWF has been largely successful in Uganda through the release and establishment of the principal natural enemy -- *C. noackii*. The natural enemy first released in 1996 has since spread to cover some non-release citrus growing areas in Uganda with spectacular impact on CWWF. This is evidence by the fact that by the

end of December 1997 the parasitoid had spread to cover 50 km from original points of release points in Iganga.

CWWF appears to prefer certain citrus variety .It was noted that CWWF was more abundant and hence harboured more *C. noackii* population on variety 'Tangarine' compared to varieties 'Hamilton', 'Red Valencia' and 'Washington'. These varieties are grown in a mixed cropping system of most areas of Uganda. This would be a favourable practice as it enables populations of *C. noackii* from favoured varieties to migrate to the other varieties of citrus.

The relative success of the biological control of CWWF in Uganda could be attributed to several factors among which could be the traditional non-chemical use in the control of the pest. This could have enhanced the rapid establishment of the parasitoids. DeBach (1976) noted that pesticides adversely affect most natural enemies. The relatively warm conditions along the lake crescent in Uganda could have enhanced the rapid development of the life stages of the parasitoid hence reducing life cycle and increasing the natural enemy generation. This could have resulted in rapid population multiplication.

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References

DeBach, P (1970). The whitefly, *Aleurothrixus floccosus* and its parasites in the Western Hemisphere OILB 'Coccids of Citrus'. Study Group Meeting in Morocco 26-31 Oct 1970. *Awamia* 37:101-104

Longo, S, Rapisarda, C, Russo A. (1985) Results of Biological control of *Aleurothrixus floccosus* Maskell in citrus orchards of eastern Sicily. Atti. XIV Conresso Nazinale Italiano di Entomologia 28 May – 1 June 1985. *Palermo Erice Bagheria*: 841-848

Ocen – Ayer, J.R, Ogwang, J.A., Sekyewa, C., and Ebun, D (1995) Survey of the citrus woolly whitefly, *Aleurothrixus floccosus* Mask in Masaka, Iganga, Kamuli and Soroti districts July 1995

Onillon, J.C. (1974) Contribution a l'etude de la dynamique des populations d'homopteres ifeodes aux argumes. Premieres observations sur le controle biologique d'*Aleurothrixus floccosus* Mask (Homoptera: Aleurodidae) par Calcs noackii (Hymenoptera:Ahlenidae). *Fruits* 29: 291-295

Viggiaani, G AND Mazzone, P (1982) The *Amitus* Hald. (Hymenoptera:Platygastridae) of Italy, *Etomologia Agraria*: 39: 59-69 , Kenya Agricultural Research Institute (1990)