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Biological control of the cypress aphid in Mafuga, Kabale district

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Abstract

The population of the cypress aphid, *Cinara cupressi* and the level of tree damage by the aphid before and after the release of a Host specific parasitoid, *Pauesia juniperorum* were monitored in Mafuga, Kabale district from 1995 - 2000. Observations were also made on the presence of parasitized mummies after parasitoid release to determine parasitoid establishment, and on the presence of any local natural enemies. Results showed that aphid population had two peaks, namely from August to September and January to mid February. Peak aphid population coincided with the dry seasons. During the first month after parasitoid release, parasitized mummies were recovered from the release cages. However, subsequent samplings between 1995 and 1998 did not recover any mummies in the cypress plantation until March 1999, thus indicating that the parasitoid had established. Surveys and samplings in surrounding cypress plantations revealed that the parasitoid had dispersed up to more than 20 km from the release site. The percentage parasitism of 8.1% is high enough, and combined with the rate of dispersal, the parasitoid should control the aphid and reduce aphid damage to trees. Results also indicate that tree damage levels dropped from damage Category 3 (26 - 60% crown damage) in 1995 - 1997 to category 2 (11 - 25% crown damage) in 1998 – 1999. Tree damage for the year 2000 was also in category 2 but tending more to category 1 (0 -10% crown damage). A number of indigenous natural enemies were recovered but they are not effective because they are general feeders.

Introduction

Planting of coniferous trees in Uganda started as early as 1946. To date there is a total of 15,514 ha of conifer trees of which one of the major species is cypress *Cupressus lusitanica* comprising 35% of the total area (Forest Dept. Unpublished data). Until recently, cypress trees were thriving without any serious insect pests. This situation however changed with the invasion and spread of the cypress aphid *Cinara cupressi* (Burkton). This exotic pest, free of its natural enemies that keep it in check in its original habitat has been able to multiply and disperse very rapidly and consequently, it has caused considerable damage to cypress trees throughout the region (Mills 1990).

The first record of *C.cupressi* in Uganda was made in Nov. 1989 (Kiwuso, 1991). It has since spread to all major cypress woodlots and hedges causing a lot of damage to the trees. Control efforts on hedges have relied on the use of chemicals but with limited success. In the plantations, this approach to aphid control would be practically impossible in view of the limited technological ability, but even then chemical application would be environmentally unsafe. An environmentally friendly control method i.e. biological control is the most preferred choice. The exotic nature of the cypress aphid makes this pest particularly suitable for classical biological control. Studies were therefore initiated in Mafuga, Kabale district to monitor the population of the aphid, its damage to trees, and implement classical biological control.

Materials and Methods

The experiment was started in 1995. A plot (30 trees x 30 trees) was set up in compartment 31 of Mafuga forest reserve. The plot was set up in the middle of the

compartment to avoid edge effect. The following were the specific objectives of the experiment:

a) To study the population dynamics of the cypress aphid
b) To monitor the damage levels on the trees
c) To characterize the local natural enemy complex associated with the cypress aphid
d) To implement trial releases of the exotic parasitoid Pauesia juniperorum
e) To monitor the establishment and dispersal of the released bioagent
f) To monitor the impact of the parasitoid on:
i) The population of the cypress aphid
ii) Damage level of the trees

For population dynamics studies of the aphid, its damage and associated local natural enemies the method used was that developed by (Day et al 1993). One hundred trees were selected at random from the plot and from each tree, one of the first five bottom branches was also randomly selected. Aphids and associated local natural enemies on the terminal 40 cm section of the selected branch were then counted and recorded. The sampling was done once a month. In addition, the damage category of the crown was recorded using a four point scale used by (Innes 1990) as follows:

Category 1	0 - 10% of crown brown
Category 2	11 - 25% of crown brown
Category 3	26 - 60% of crown brown
Category 4	61 - 100% of crown brown

P.juniperorum, a primary parasitoid of Cinara spp was imported into Uganda under quarantine in 1995 and 1996 for trial releases against the cypress aphid. During releases, three pairs of (male and female) adult parasitoids were placed in cylindrical sleeve cages measuring approximately 25 cm (diameter) and 50 cm (length). The cages were made of muslin cloth wrapped around frames of bendable wire. The cages were then singly placed on heavily infested tree branches. Any other local natural enemies were removed from the caged branch before releasing the parasitoid in order to reduce competition and interference. After two weeks from release date, the cages were opened and the number of mummies was recorded. Thereafter inspection of mummies was done every 3 days for 2 weeks.

Monitoring the establishment, dispersal and impact of the parasitoid was done 4 weeks after release using the method developed by Day et al. (1993). The number of mummies and adult parasitoids recovered were recorded. In addition the number of aphids, damage category and local natural enemies were recorded. Surveys were also conducted at various locations surrounding the release site for the presence of parasitized aphids (mummies) and adult parasitoids.

Results and discussion

Tree damage

The greatest percentage of trees sampled in 1995 - 1997 were in damage category 3 (Fig 1). This damage was high enough to warrant control. Category 4 consistently had the least number of trees indicating that very few trees had been irreversibly damaged and so the forest could be salvaged from total death if a control measure was to be instituted.

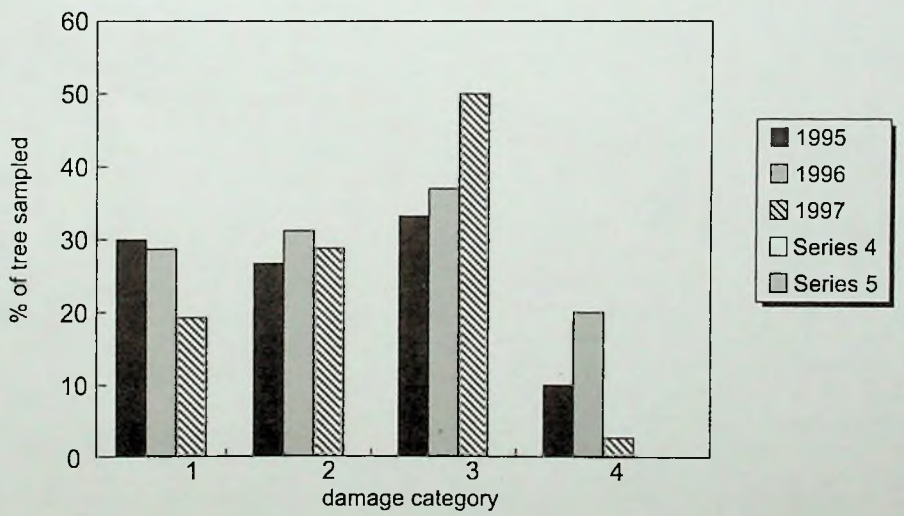
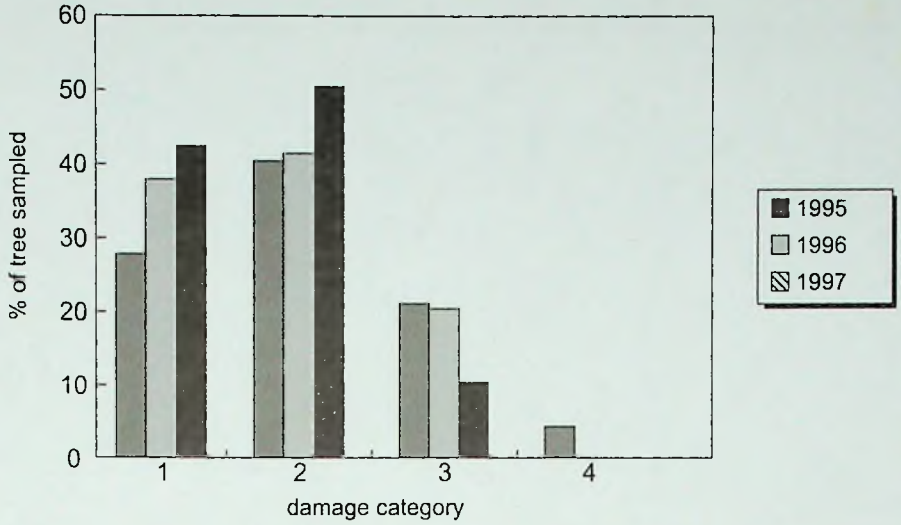


Fig1: Percentage of trees in the different damage categories, 1995 - 1997



Tree damage for years 1998, 1999 and 2000 declined to category 2, thus indicating that the parasitoid that had been released was probably establishing and parasitizing the aphids, thus reducing the damage. Other factors such as weather, tree phenology and indigenous natural enemies could also have contributed to the decline in tree damage.

Aphid abundance

Aphid populations during 1995 - 2000 are shown in Fig.3 - 5. For most of the years, there were two population peaks, one in January - February, and a more pronounced one in August - October. Population peaks coincided with dry periods. Highest population peaks

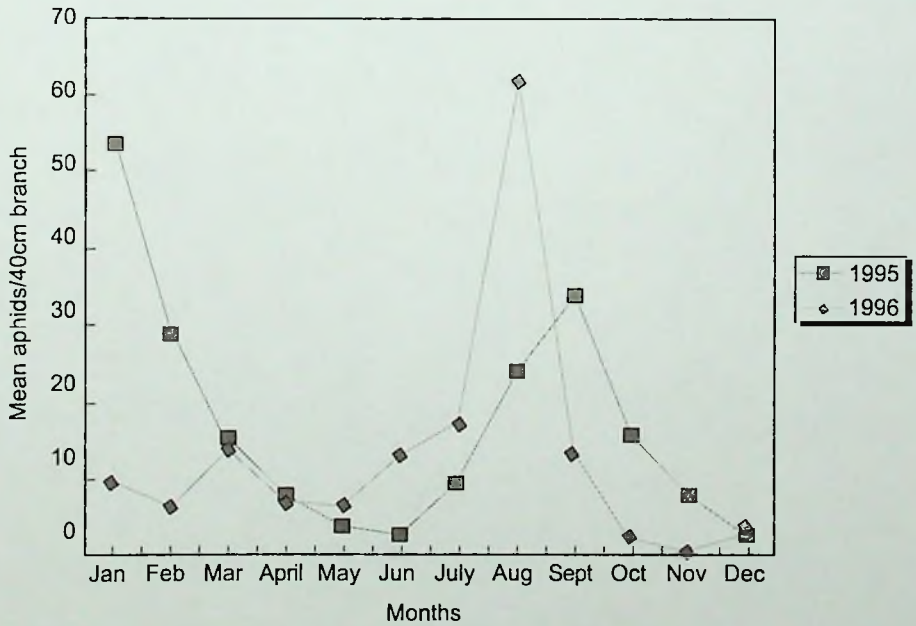


Fig 3: Aphid populations in cypress plantation at Mafuga, Kabale, 1995 & 1996

Fig 4: Aphid populations in cypress plantation at Mafuga, Kabale, 1997 & 1998

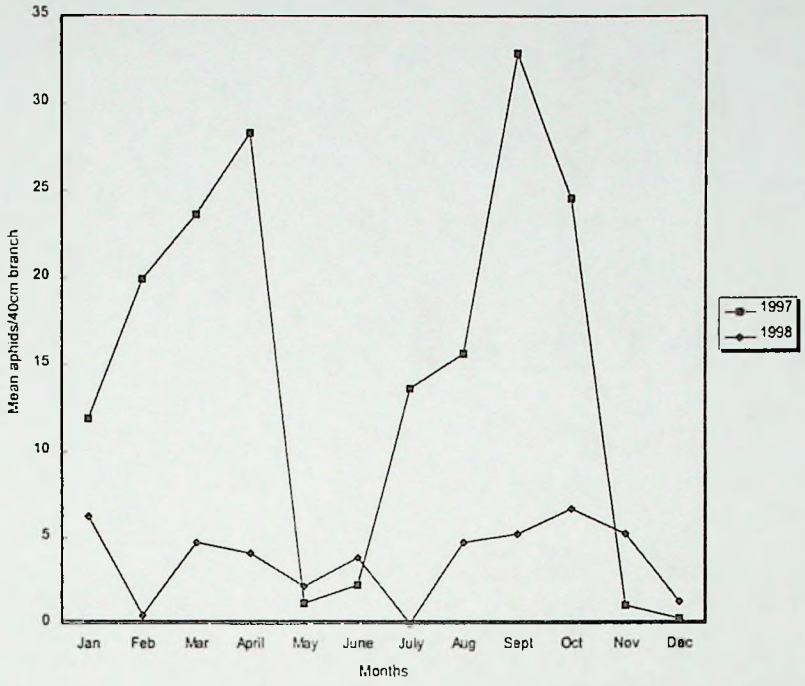
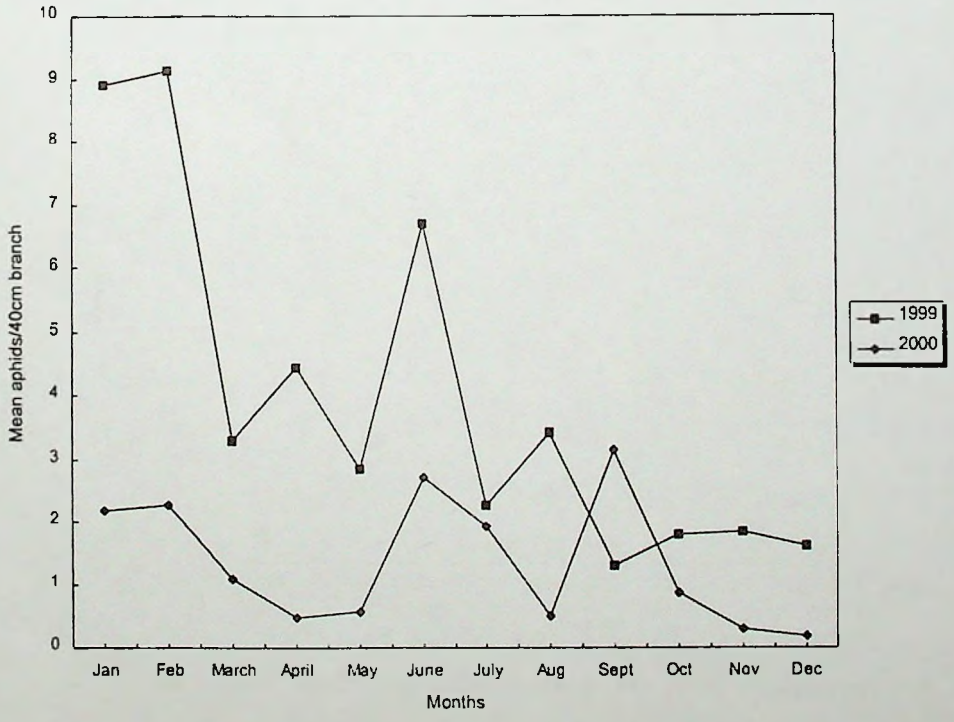


Fig 5: Aphid populations in cypress plantation at Mafuga, Kabale, 1999 - 2000



were observed in Jan. 1995 and Aug. 1996 respectively. Populations declined tremendously in subsequent years. Possible reasons for this decline are given in the section on impact of P.juniperorum on cypress aphid.

- **Local natural enemy complex**

Only predatory local natural enemies were observed attacking the cypress aphid (Table 1). Their population was however low throughout the study period. No local parasites were observed during the study.

These natural enemies are general feeders and can not concentrate on the cypress aphid greatly enough to cause any significant impact on the aphid population.

Table 1: Local predators found attacking the cypress aphid in Mafuga, Kabale district

Group	Predatory Stage	Spp	Remarks
Coccinellidae (Coleoptera)	Larva & adult	*Chelomens propingua, C.aurora, Platynaspis spp,Exochomus spp*	Most abundant predatory insects encountered
Syriphidae (Diptera)	Larva		Common predator
Crysopidae (Neuroptera)	Larva & adult	*Crysopa canea*	Larvae main predatory stage
Aranae (Spiders)	All mobile stages		Though not insects they were the most abundant. indigenous natural enemies

Establishment and dispersal of *P.juniperorum*

An insect population is said to be establishing in a new environment when it becomes self sustaining so that it can grow and spread independently of any external factors (Kfir and Kirsten 1991). Culliney and Beardsley (1988) observed that for an introduced biological control agent, survival through several generations and dispersal from the release site are early good indicators of successful establishment.

In this experiment, although mummies were recorded in the release cages during the first 5 weeks after release, no mummies were recorded during the subsequent samplings right from 1995 to 1998 thus suggesting non-establishment of the parasitoid. In 1999 however, mummies and adult parasitoids were recovered in compartment 4 which is 7 to 8 km from the release site. The populations were however very low. During the same period, mummies and adult parasitoids were also observed on cypress hedges near Kabale town, a distance of about 20 km from the release site. This was a sign of parasitoid establishment and dispersal.

The reason for the apparent failure of the parasitoid to establish during the period 1995 - 1998 could have been due to lack of climatic adaptation since P.*juniperorum* released was collected from Europe. Only a very small population of those released were able to survive and were difficult to detect that early. The parasitoids that survived, eventually adapted to the new harsh

Table 2 Mean aphids and tree damage levels between 1995 - 2000

Year	% Parasitoid	Mean aphids/ 40 cm branch	Highest damage category	Remarks
1995	0	17.3	3	9% in category 4
1996	0	13.1	3	19% in category 4
1997	0	14.5	3	2% in category 4
1998	0	4.0	2	3% in category 4
1999	8.1	3.3	2	0 in category 4
2000	9.5	1.34	2 tending to	0 in category 4, category 1

environment and their population slowly increased to observable levels in 1999.

Impact of *P.juniperorum* on cypress aphid

Evidence of parasitoid establishment was first noticed in March 1999. Since then, regular monthly sampling in the plot set up in compartment 31 have consistently recovered mummies. Average parasitism between March - December 1999 was 8.1%, and 9.5% in 2000 (Table 2). This parasitism is considered high enough to have significant impact on the cypress aphid population. Indeed mean aphid populations decreased from 17.3 to 1.34 aphids/40 cm branch in 1995 and 2000 respectively (Table 2). Similarly tree damage levels decreased. This decline may be attributed among other factors to the parasitoid effect on the aphid population.

Conclusion and recommendations

The results of this study show that P.juniperorum has established in Mafuga and is having a significant effect on the cypress aphid. Since this establishment was observed only at the beginning of 1999 there is need to continue monitoring to determine the speed and pattern of dispersal of the parasitoid. Most of the cypress trees and plantations are located all over the country. It may be necessary to redistribute these biological agents to those areas to control the aphid. Further monitoring of the impact will also be necessary.

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