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An Area Wide Control of Fruit Flies in Mauritius

P Sookar, S Permalloo, B Gungah, M Alleck, S I Seewooruthun and A R Soonnoo,

Ministry of Agro Industry & Fisheries Réduit Republic of Mauritius ento@intnet.mu; moa-entomology@mail.gov.mu

ABSTRACT : An area-wide National Fruit Fly Control Programme (NFFCP) was initiated in 1994, funded by the European Union until 1999 and now fully financed by the Government of Mauritius. The NFFCP targets some 75,000 backyard fruit trees owners mainly. The bait application and male annihilation techniques (BAT & MAT) are currently being applied against the fruit flies attacking fleshy fruits and are targeting selected major fruit growing areas in the north, north-east, central and western parts of the island. Successful control has been achieved using these two techniques as demonstrated by trap catches and fruit samplings. The level of fruit fly damage to fruits has been reduced. Presently, the bait-insecticide mixture is being supplied free of charge to the public. The current status of the area-wide suppression programme is such that continuous use of BAT/MAT is a never ending process and as such is not viable. In this context, a TC project on 'Feasibility studies for integrated use of sterile insect technique for area-wide tephritid fruit fly control'. Studies are also being carried out on mass rearing of the peach fruit fly for small scale trials on SIT so as to eventually integrate this control method in our area-wide control programme.

Key Words: *Bactrocera zonata*, *B. cucurbitae, Ceratitis rosa, C. capitata*

INTRODUCTION

Fruit flies of the Family Tephritidae are some of the most destructive and important pests of fruits and vegetables worldwide. The two species of fruit flies indigenous to the Mascarene Islands are *Ceratitis catoirii* (Guérin-Méneville) and the Indian Ocean cucumber fly *Dacus d'emmerezi* (Bezzi). The latter is still present in Réunion Island, Madagascar and Mauritius. While *C. catoirii* still occurs in Réunion, the last record from Mauritius dates back to 1960 (Orian and Moutia 1960). Other fruit fly species have been introduced in the region, mainly from the Asian and African Regions. The Mediteranean fruit fly *Ceratitis capitata* (Wiedemann) and the melon fly *Bactrocera cucurbitae* (Coquillett) were probably introduced around the end of the 19th century and the beginning of the 20th century, respectively (Orian and Moutia 1960). Both the natal fly, *C. rosa* (Karsch) and the tomato fruit fly *Neoceratitis cyanescens* (Bezzi) have been introduced in the 1950's (Orian and Moutia 1960). Although the peach fruit fly, *B. zonata* (Saunders) was recorded in 1942, it subsequently disappeared and was found again as an established population in 1987 (Anon, 1988). As far as *Dacus punctatifrons* Karsch is concerned, one specimen was collected in 1977 (Roy, 1977) and no other specimen has been collected up to now. The ber fly *Carpomya vesuviana* Costa was first recorded in 1986 (Anon, 1987) and is now an established pest of jujube (*Ziziphus jujube* Lam.). The Ethiopian fruit fly *Dacus ciliatus* Loew was recorded in 1901. *Bactrocera montyanus* was first recorded in 1922 (Orian and Moutia 1960). It was believed that this fly had disappeared until one specimen was found in 1999 (Eydatoulah, 1999). The Oriental fruit fly *Bactrocera dorsalis* (Hendel) was recorded for the first time on 5th June 1996 and then declared eradicated on 1st July 1999 (Seewooruthun *et al.,* 2000).

Fruit flies show rapid reproductive potential with short and overlapping generations and sudden outbreaks (Bateman, 1972). Their significance is further increased by a growing international trade (Drew and Allwood, 1997). The high fruit fly populations and the abundance of both cultivated and wild fruits throughout the year combine to maintain the status of the fruit flies as the major pests of cultivated fruits. Economically important fruit flies of fleshy fruits in Mauritius are, in order of importance, *B. zonata*, *C. rosa*, *C. capitata* and *C. vesuviana*. Preferred cultivated hosts for

Author for correspondence:
P Sookar

the first three species are mango (*Mangifera indica* L.), guava (*Psidium guajava* L.), peach (*Prunus persica* (L.) Batsch), loquat (*Eriobotrya japonica* (Thunb.) Lindl.), water apple (*Syzygium samarangense* (Blume Merry and Perry), citrus (*Citrus* spp.) and custard apple (*Annona reticulata* L.) while the most heavily attacked wild fruits are Indian almond (*Terminalia catappa* (L.) Ridley) and Chinese guava. *C. vesuviana* is specific to jujube (*Ziziphus jujube* Lam.). Fruit flies can be controlled effectively by regular applications of cover sprays using insecticides (Anon 1986); however, this method of control may be detrimental to bees and other beneficial insects. A National Fruit Fly Control Programme (NFFCP) has been ongoing since 1994. The programme aims at controlling fruit fly infestations over a large area by the use of Bait Application Technique (BAT), followed by Male Annihilation Technique (MAT). The first phase (BAT) would bring down the fruit fly populations to very low levels and the second phase (MAT) would maintain the populations at these low levels. The NFFCP was initially funded jointly by the European Union and the Government of Mauritius. As from 1999, the latter is fully supporting the programme.

CONTROL OPERATIONS

BAT and MAT are considered to be safe and cheap. These two techniques have been used for suppression of populations of fruit flies in selected regions of the districts of Flacq, Pamplemousses and Rivière du Rempart (Figure 1) depending on the fruiting seasons. Selection of the geographical area of application was dependent on several factors; the main ones being cost and logistics; this area covers 600 km^2 and represents about one third of the country's total area; it accounts for 40 % of the National fruit production by about 54000 planters, and it has a good road network; it also clearly demarcates the treated and untreated zones by sugar cane plantations which form a natural barrier.

Nine vehicles are attached to the Programme and around 80 persons are involved full time in its implementation.

Fig. 1. Map of Mauritius showing fruit fly trap locations and treated districts.

BAIT APPLICATION TECHNIQUE

Bait sprays using Malathion 57% Emulsifiable Concentrate (EC) provide a high degree of fruit fly control and constitute an advantageous substitute for traditional insecticide cover sprays which are rather costly and hazardous to the environment (Jenkins and Sheldy 1959, Allwood 1989). A mixture of water (carrier), protein hydrolysate (a food attractant), and Malathion 57 EC (insecticide) in the ratio of 98.6 : 0.7 : 0.7 is used, at a rate of less than 2 L mixture per hectare (including < 8 gm of Malathion/ hectare).

This method is relatively safe to non-target insects and is also less polluting to the environment than cover sprays, as it produces very little spray drift and very little chemical residue. The solution is applied at the rate of 40 ml as a coarse spot spray on the undersides of foliage at 7 to 10 days intervals. The locality to be treated is selected on the basis of the fruiting season.

MALE ANNIHILATION TECHNIQUE

After reducing the fly populations to very low levels using the area-wide protein bait spray, the second phase (MAT), is implemented. MAT uses parapheromones in lured blocks to mass-trap males, thereby reducing the mating success of females. It is expected that MAT, which kills only males, as opposed to BAT which kills both sexes, will maintain the fly populations at these very low levels. In the MAT phase, 12 mm thick plywood blocks 50 mm x 50 mm are impregnated with different lures namely Methyl eugenol (67 %), Trimedlure (62 %), Cuelure (67 %) and Malathion ULV and these blocks are nailed on fruit trees. Methyl eugenol attracts males of Peach fruit fly; Trimedlure targets the Natal fly and Medfly while Cuelure attracts the Melon fly. These killer blocks are placed at 50 m intervals in isolated areas and at 33 m in built-up areas; this is equivalent to 4 blocks per hectare and 9 blocks per hectare, respectively. Since no pheromones are known for the ber fly, control is achieved solely by BAT which is applied during the jujube fruiting season.

MONITORING

Fruit fly monitoring is an important activity in any area wide fruit fly management programme (Hammes 1980; Jang et al. 1994). Surveys of host fruits have been carried out in the treated and untreated areas since the start of the NFFCP. Collected fruits which consist mostly of fallen fruits are counted, weighed and incubated for two weeks. Pupae are sieved and then placed in Petri dishes for adult emergence. Adult flies are counted and identified.

Locally developed traps based on the Steiner model, lured with either methyl eugenol, trimedlure or cuelure are used for detection of adult male flies. Figure 1 shows the trap locations. Traps are checked and relured every fortnight with 0.1 ml of a lure/malathion 57 EC mixture in the ratio of 1:1. There are 732 fruit fly traps throughout the island.

EXTENSION

Extension work is carried out regularly to publicise the programme. Letters to householders, display boards, talks in schools and over the radio, posters, stickers, and a video film, have been used to create public awareness. Radio and television publicity spots have been largely used to sensitise the public on the National Control Programme.

QUARANTINE

Quarantine procedures are necessary to ensure that exotic pests do not enter a geographic location where they do not currently exist. A trap grid, using all available lures, has been placed at the port and airport for the detection of any new fruit fly pest entering the island. The Division also works in close collaboration with the National Plant Protection Office of the Ministry to prevent the entry of other new pests. Pantry refuses which include raw fruits and vegetables are regularly collect-

ed and incinerated. Moreover a quarantine bin has been placed at the airport to allow incoming passengers to discard fresh and undeclared fruits and vegetables, following an announcement on the plane.

ERADICATION OF THE ORIENTAL FRUIT FLY

The Oriental fruit fly, *B. dorsalis* (Hendel), was first detected in Mauritius in June 1996. This was the first record for the African region. The availability of material, equipment, trained personnel, as well as adequate technical know-how made it possible to intervene immediately at the site of detection. An area of about 1 km^2 was subjected to the bait application technique (BAT) and the male annihilation technique (MAT), within 24 hours of detection. Trapping was intensified around the detection point. Methyl eugenol traps were placed in a radius of 1.5 km from the outbreak centre. Following subsequent catches in traps about 1 km from the first detection point, treatments were gradually extended till a total area of 300 km^2 was covered by the eradication programme. Treatments comprised of: BAT, using 2% protein hydrolysate and 0.7% malathion; MAT, using plywood blocks of 50 mm x 50 mm x 12 mm with 6 g of methyl eugenol and 1 g of malathion 57 EC; cover spray of trees with ripening fruits; soil drenching under trees with ripening and fallen fruits; fruit clean-up and disposal. All the measures together resulted in the eradication of the fly from Mauritius (Seewooruthun *et al.,* 2000a; 2000b).

STATISTICAL ANALYSIS

Trap catches between the treated and untreated regions were log transformed and then analysed by ANOVA. The number of flies per kg fruit between the treated and untreated regions were analysed by ANOVA. All analyses were done with the statistical software GraphPad Prism 4.

RESULTS

The effectiveness of control in the targeted area has been demonstrated by a reduction of larval infestation in both wild and cultivated fruits, and by a simultaneous decrease in fruit fly trap catches. Moreover, peach which is highly susceptible to fruit fly attack with an infestation of almost 100 % if not treated, has been produced in backyards after many years and was sold in the market.

Fruit infestation figures show that mango infestation with *B. zonata* was significantly lower (P=0.0078, F=8.75) in the treated areas as compared to the untreated areas (Figure 2). Similarly, guava infestation with *B. zonata* was significantly reduced (P<0.0001, F=26.20) by the BAT and MAT treatments (Figure 3). Infestation of the wild fruit, Indian almond by *B. zonata* (Figure 4) and *C. rosa* (Figure 5) was significantly reduced by the treatments (P<0.0001, F=36.36 and P=0.0018, F=11.11, respectively).

The control programme has been effective in maintaining significantly lower fruit fly population levels in all treated areas. There was a significant decrease (P<0.0001, F=157.10) in the captures of *B. zonata* in the treated areas as compared to the untreated areas (Figure 6). The BAT and MAT treatments significantly reduced (P<0.0001, F=49.25) the population of *C. rosa* (Figure 7). However, there was no significant difference (P=0.05, F=3.90) in trap captures of *C. capitata* between the treated and untreated areas (Figure 8). A significant decrease (P<0.0001, F=28.27) in the population of *B. cucurbitae* (Figure 9) was also obtained in the treated areas.

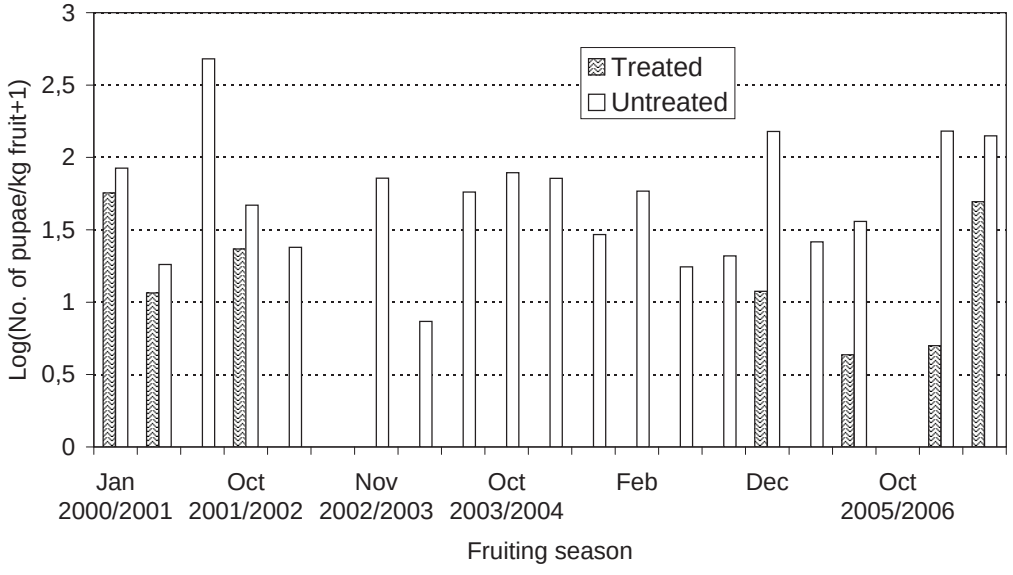

Figure 2. Mango infestation with B. zonata in treated and untreated areas

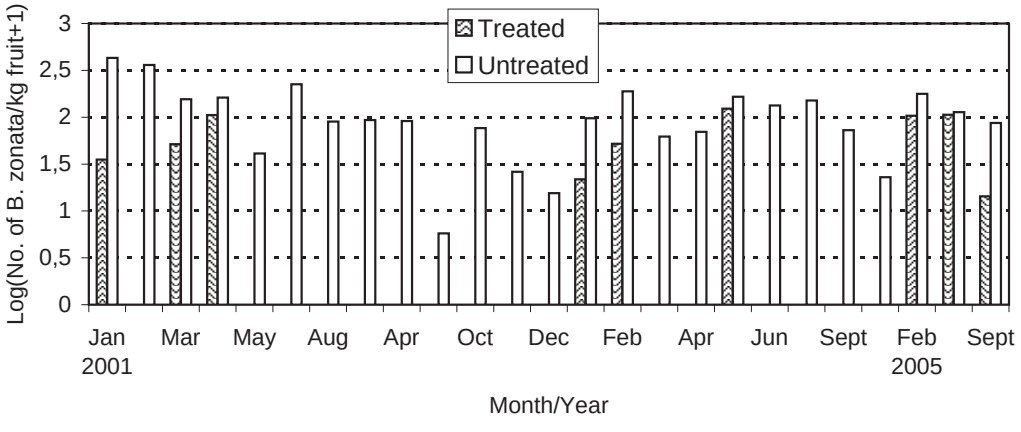

Figure 3. Guava infestation with B. zonata in treated and untreated regions

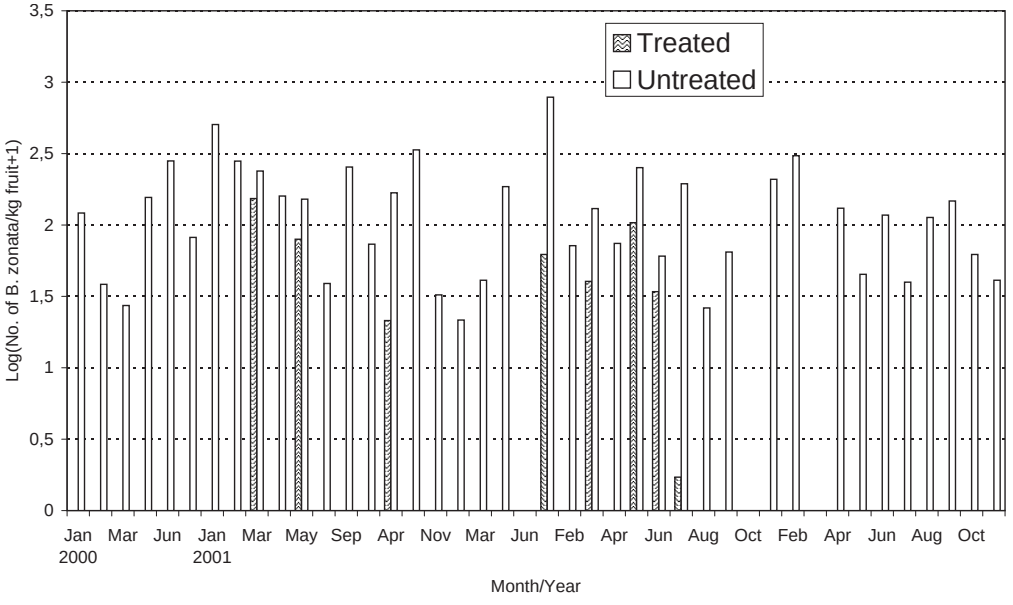

Figure 4. Indian Almond infestation with B. zonata

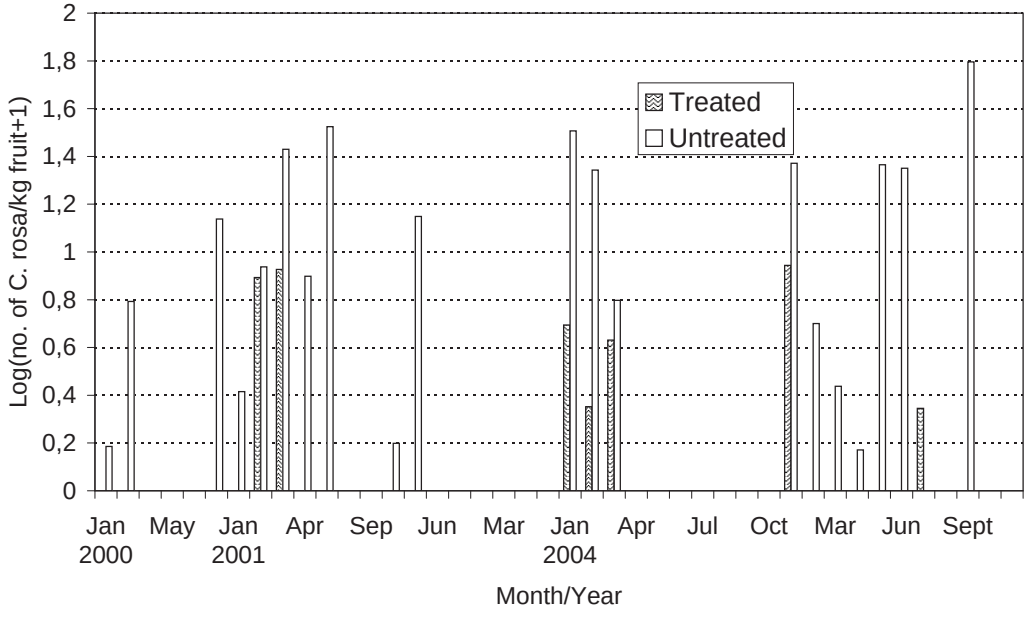

Figure 5. Indian Almond infestation with *C. rosa*

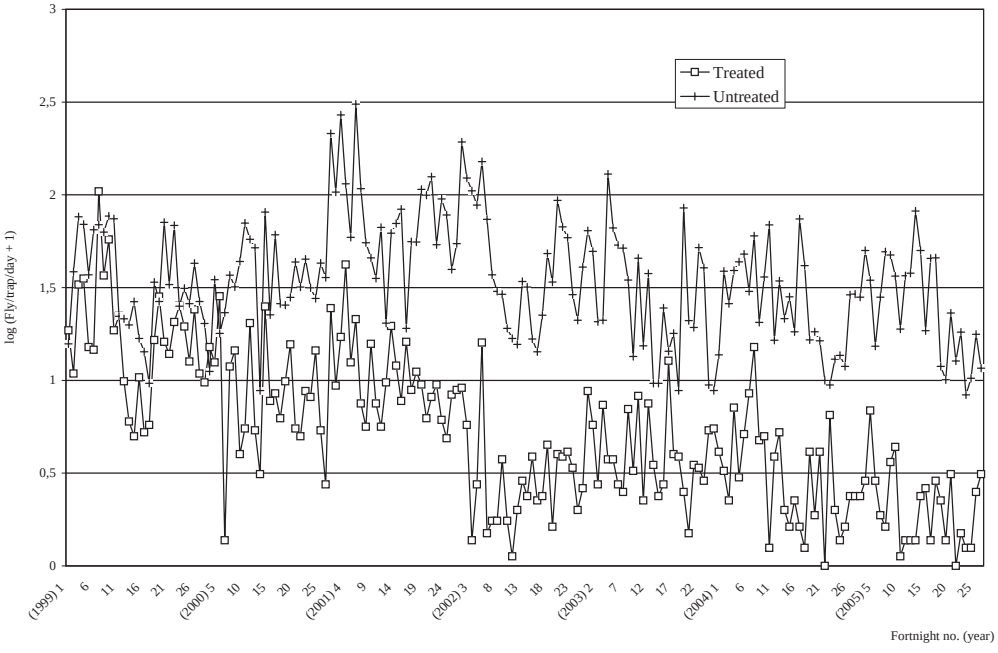

Figure 6. Trap catches of Bactrocera zonata in treated and untreated zones

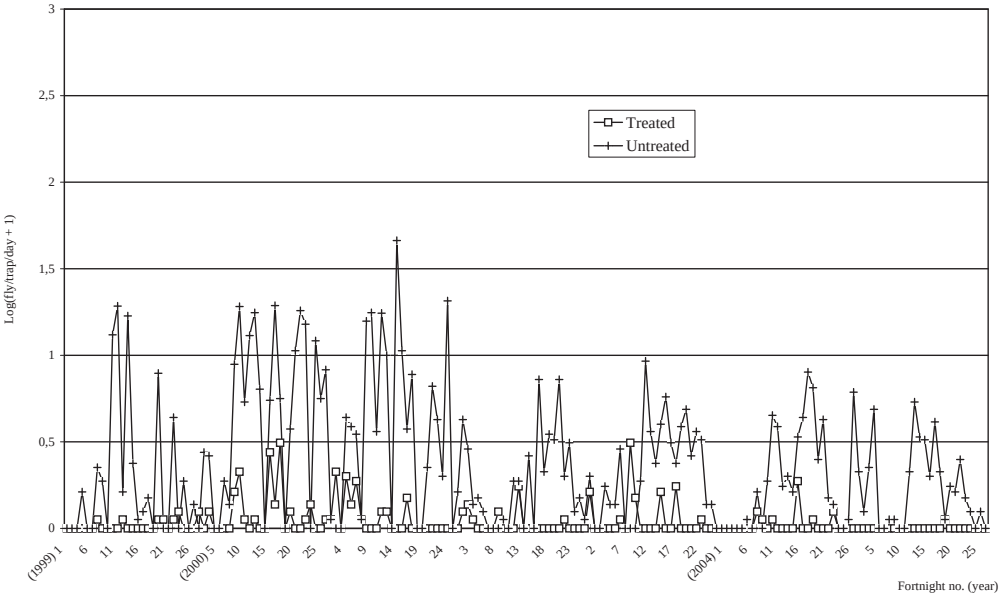

Figure 7. Trap catches of Ceratitis rosa in treated and untreated zones

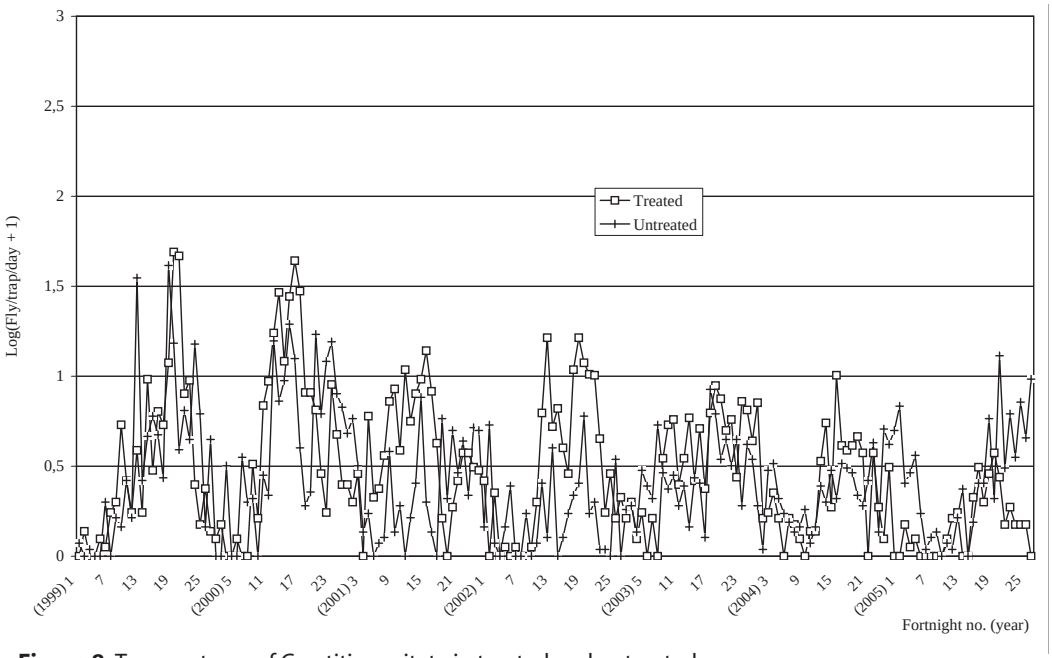

Figure 8. Trap captures of Ceratitis capitata in treated and untreated zones

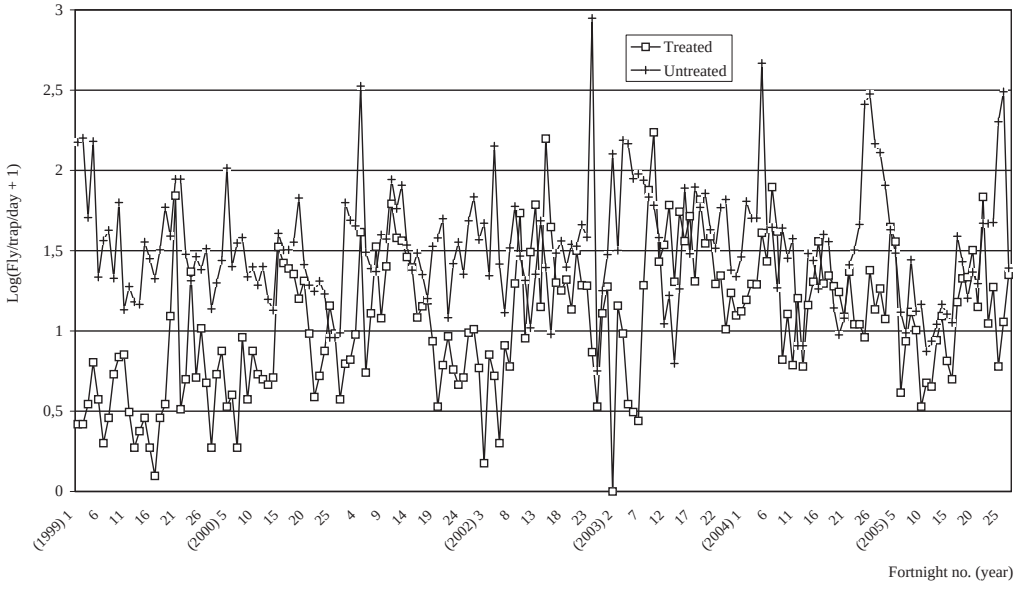

Figure 9. Trap catches of Bactrocera cucurbitae in treated and untreated zones

DISCUSSION AND CONCLUSION

The population of *Ceratitis capitata* and *Ceratitis rosa* were already low at the start of treatment. Both species have been displaced by the more aggressive peach fruit fly. After the implementation of the control programme, there was no marked difference in the trap catches for *C. capitata* in both the treated and untreated zones (Figure 9). However, the trap catch for *C. rosa* decreased significantly.

The population of *B. zonata* which is the main fruit fly of fleshy fruits, showed a significant decline after applying the control measures. However, despite a reduction in fruit infestation levels in the treated areas, peach fruit fly attack was still persistent throughout the year. Hence, the control measures were not effective enough to further lower down the peach fruit fly populations. Fallen fruits in backyards act as a reservoir of the pest. In most cases, fallen fruits are left on the ground and hence contribute in continuously flooding the population of the pest. Fruit sanitation is an essential component of the integrated control programme. For an effective control, fruit sanitation is being encouraged in backyards.

The accidental introduction of the oriental fruit fly, *B. dorsalis* in June 1996 caused a disruption in the programme as the same resources and logistics were used to eradicate this new pest. Hence, fruit infestation levels and trap catches rose slightly during the period November 1996 and June 1997. After the resumption of normal operations, the fruit fly populations in treated regions gradually decreased.

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