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EFFICACY OF PROTEIN BAIT SPRAYS IN CONTROLLING FRUIT FLIES (DIPTERA: TEPHRITIDAE) INFESTING ANGLED LUFFA AND BITTER GOURD IN THAILAND

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***ABSTRACT.* –** The efficacy of Australian Pinnacle protein bait and Thai yeast bait to control *Bactrocera cucurbitae* (Coquillett) and *B. tau* (Walker) infestations in angled luffa and bitter gourd was tested. *Bactrocera diversa* (Coquillett) was the only species found infesting flowers of angled luffa and none was found on bitter gourd. The angled luffa plot treated with Pinnacle and bitter gourd plots treated with either Pinnacle or Thai bait had considerably lower percent infested fruits when compared with the untreated plots. Yields obtained in the angled luffa plot treated with Pinnacle were 81.57% higher than in the untreated plot and in the bitter gourd plots treated with either Pinnacle or Thai bait, increased yields were 67.22% and 59.98% higher, respectively, than in the untreated plot. *Bactrocera cucurbitae* and *B. tau* were the only two species that infested fruits of both crops. Among dead fruit flies feeding on the poison baits, collected from funnel traps, *B. cucurbitae* and *B. tau* were the most common species. Other species found in the traps in angled luffa plots were *B. carambolae* Drew & Hancock, *B. papayae* Drew & Hancock, *B. diversa* (Coquillett), *B. umbrosa* (Fabricius), *B. caudata* (Fabricus), *B. tuberculata* (Bezzi), *B. latifrons* (Hendel) and *Adrama rufiventris* (Walker). In the bitter gourd plot, other species found were *B. dorsalis* (complex), *Anomoia kraussi* Hardy and *Acroceratitis tomentosa* Hardy in the plot treated with Pinnacle; and *B. dorsalis* (complex) and *B. caudata* in the plot treated with Thai bait. More females than males were collected in the traps in both crops.

***KEY WORDS.* –** Protein bait sprays, fruit flies, *Bactrocera cucurbitae*, *Bactrocera tau*, angled luffa, bitter gourd.

INTRODUCTION

Fruit flies (Diptera: Tephritidae) in the subfamily Dacinae occur throughout the tropics and subtropics of the world and cause considerable economic damage to fruit and vegetable crops. With increasing emphasis on quality of fruit and vegetable produce and with the possibility of expansion of trade in horticultural commodities, the countries importing as well as exporting are giving increasing attention to fruit fly management at preharvest and postharvest levels (Drew, 1992).

The melon fly, *Bactrocera cucurbitae* (Coquillett) is an economically important pest of cucurbit crops. Its geographical distribution covers most countries in South East Asia and its wide host range includes many cucurbit species e.g., *Cucumis sativus* L., *Luffa acutangula* Roxb., *Momordica charantia* L. and *Cucurbita maxima* Duch (Allwood et al., 1999).

Bactrocera tau (Walker) is also an important pest species damaging cucurbit plants, with host plants and geographical distributions similar to those of *B. cucurbitae* (Allwood et al., 1999).

Some preharvest control measures have been reported on both pest species but especially *B. cucurbitae.* Insecticides such as pyrethroids (Borah, 1997) and triazophos (Reddy, 1997) have been used in cover sprays on cucurbit crops. Most biological control studies on the melon fly were carried out to determine the biology and ecology of its parasitoids (Liquido, 1991; Purcell & Messing, 1996; Messing et al.,

1996). Bagging bitter gourd fruits in Taiwan against *B. cucurbitae* was successful in increasing the yield and net income by 45% on bitter gourd and 58% on angled luffa (Fang, 1989).

Recently trials on cultural control methods were conducted. In India the influence of sowing seasons and crop varieties on the infestation of *B. cucurbitae* in cucumber (Borah, 1996), planting seasons on bitter gourd (Joshi et al., 1995), use of trap crops (*Cucurbita pepo* L. var. Melopepo) on melon (Khan & Manzoor, 1992), and cultivation practices to destroy fly pupae in the soil (Agarwal et al., 1987).

Literature on control measures on *B. tau* is scarce. A mixture of molasses and fenvalerate as a bait spray gave satisfactory control of this pest on angled luffa (Saikia & Dutta, 1997). Some ecology studies have been done on *B. tau* such as population fluctuations on bitter gourd, cucumber, bottle gourd and sponge gourd (Gupta et al., 1992); host specific demographic studies (Yang et al., 1994); and monitoring of pheromone traps to observe its seasonal population dynamics (Chen et al., 1995).

Because of concerns over damage to the environment and human health, by insecticide cover sprays for fruit fly control, a protein bait spray technique has been developed (Sabine, 1992). Protein baits attract both male and female fruit flies, making them more effective than the male attractant method for field pest management (Sabine, 1992).

Protein used in bait sprays has been tested from several sources. In Queensland a yeast autolysate is produced (Smith & Nannan, 1988; Sabine, 1992) and has proven most successful. In addition the Malaysian Agricultural Research and Development Institute (MARDI) developed a new yeast protein formulation, commercially called PROMAR, which successfully controlled fruit fly in starfruit (Vijaysegaran, 1989; Loke et al., 1992), soursops and chili (Sabine, 1992).

Only a few experiments on the application of bait sprays on cucurbit crops have been reported. Angled luffa (*L. acutangula*) and bitter gourd (*M. charantia*) are the two most important cucurbit crops in Thailand. Therefore, protein bait spray trials were done on these two crops. The experiments were carried out in Songkhla Province, southern Thailand.

The objective of the studies was to determine the efficacy of the Australian protein bait (Pinnacle) in controlling *B. cucurbiate* and *B. tau* on angled luffa and Pinnacle and Thai bait on bitter gourd under field conditions.

Pinnacle is a low salt yeast autolysate bait supplied from Queensland and the Thai bait was a formulation from brewery waste yeast provided by the Department of Agriculture, Thailand. These experiments were conducted under an ACIAR fruit fly project.

MATERIALS AND METHODS

***Angled luffa trial.* –** The experiments on angled luffa (*L. acutangula*) were conducted over two separate farms, seperated by approximately 80 m. Each comprised an area of 1,500 m^2 with plant spacing (hill x row) of 0.5x2 m. The first field was sprayed at 5 day intervals using Pinnacle (420 g/L) at 14 g a.i./L mixed with trichlorfon (95% sp) at 6 g a.i./L. The mixture was applied from a power knapsack sprayer at a pressure of 2 bar (flow rate of mixture approximately 700 ml/minute) to the underneath of foliage. Approximately 15-20% of foliage was treated by applying a continuous line on one side of every second row. The first application of bait was commenced at the fruit setting period (approximately 45 days after planting) and consecutive applications were undertaken until the plants died. The second farm was used as the untreated control.

Bait attractancy was tested by placing a cardboard funnel trap (0.5 m diameter), coated with parafin wax, under treated areas of angled luffa. A plastic basket (30 cm in diameter) was placed at the base of the funnel and a plastic tube containing 5% formalin was inserted into the base of the basket. The tube was buried 7 cm into the ground (Fig.

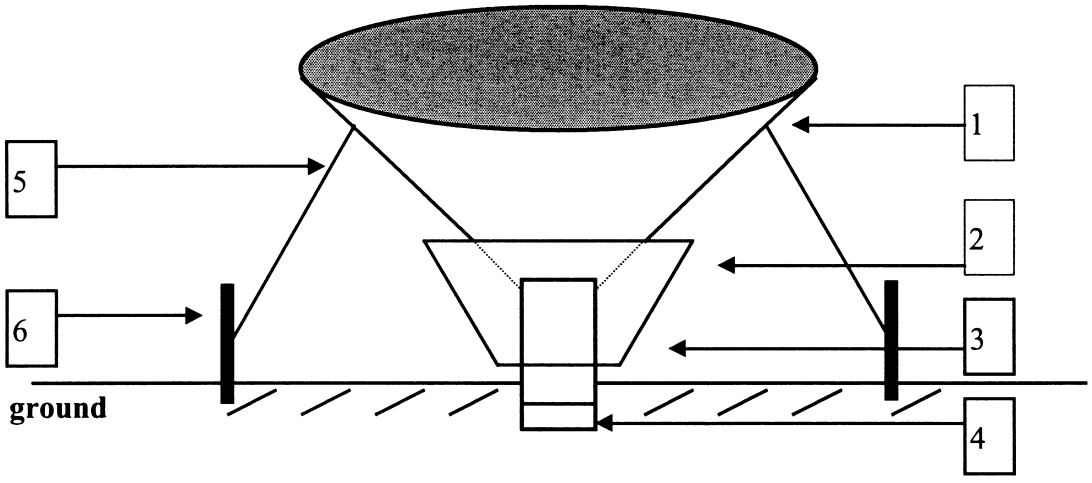

Fig. 1. Funnel trap for dead fruit flies collecting in plots treated with baits (1=waxed cardboard funnel; 2=plastic basket; 3=plastic glass, 4=formalin (5%), 5=string and 6=post).

1).Two traps were placed in each row. Adult fruit flies killed by feeding on the bait were collected from the traps before each new bait application. Numbers and sex of each fruit fly species were recorded.

A total of 2,400 fallen flowers and all mature fruits from untreated and treated fields, were sampled at three and five day intervals. The collecting of the flowers and fruits began in the treated and control plots 57 and 60 days after planting, respectively. Collected samples were held in laboratory cages for 10-14 days to allow emergence of fruit flies for identification and recording of data. Efficacy of the bait trials was assessed by both percent of infested fruits and crop yields.

***Bitter gourd trial.* –** The bait trial on bitter gourd (*M. charantia*) was conducted at three separate farms. Each was an area of 1,900 m^2 separated by approximately 150 m with plant spacing of 1x2 m. The first field was sprayed with Thai protein bait at 33 ml/L mixed with trichlorfon (95% sp) at 6 g a.i./L, the second with Pinnacle bait and the third was the untreated control. The Thai bait and Pinnacle treated plots were sprayed at 6-day intervals. Fallen flowers and marketable fruits from each plot were first collected at 60 days after planting and then every three days. On each fruit sampling occasion, all fruits were harvested but only 25% were randomly selected as a subsample to assess percent infestation. Other procedures such as bait mixture and applications, funnel traps and dead fruit fly sampling were as described for the angled luffa trial.

RESULTS

***Species and number of fruit flies reared from fallen flowers.* –** *Bactrocera diversa* (Coquillett) was the only species reared from angled luffa flowers. Two flies were reared from 55,520 flowers in the plot treated with Pinnacle bait while there were 827 flies from 55,520 flowers in the control plot. The fly populations obtained from the Pinnacle treated plot were low for the whole planting season while in the untreated plot they fluctuated from time to time (Fig. 2).

No fruit flies were reared from the bitter gourd flowers from any of the plots i.e. Pinnacle (34,520 flowers), Thai bait (26,725 flowers) and untreated (21,740 flowers).

***Species of fruit fly reared from infested fruits, percent infestation and crop yields.* –** *Bactrocera cucurbitae* and *B. tau* were the only two species that infested fruits of both crops. *Bactrocera cucurbitae* was the dominant species (Figs. 3, 4); even some species of fruit flies e.g. *Bactrocera caudata* collected from funnel traps (Figs. 5, 6) reported as a potential pest of Cucurbitaceae crops (Hardy, 1973) was not found in fruits in this experiment.

Both angled luffa and bitter gourd had lower percent fruit infestation and higher marketable crop yields when treated with the protein baits. In the angled luffa trial, percent infestation under Pinnacle protein bait treatment remained low (0.94%) while in the untreated plot it was high (31.36%) on early sampling dates and then gradually decreased (Table

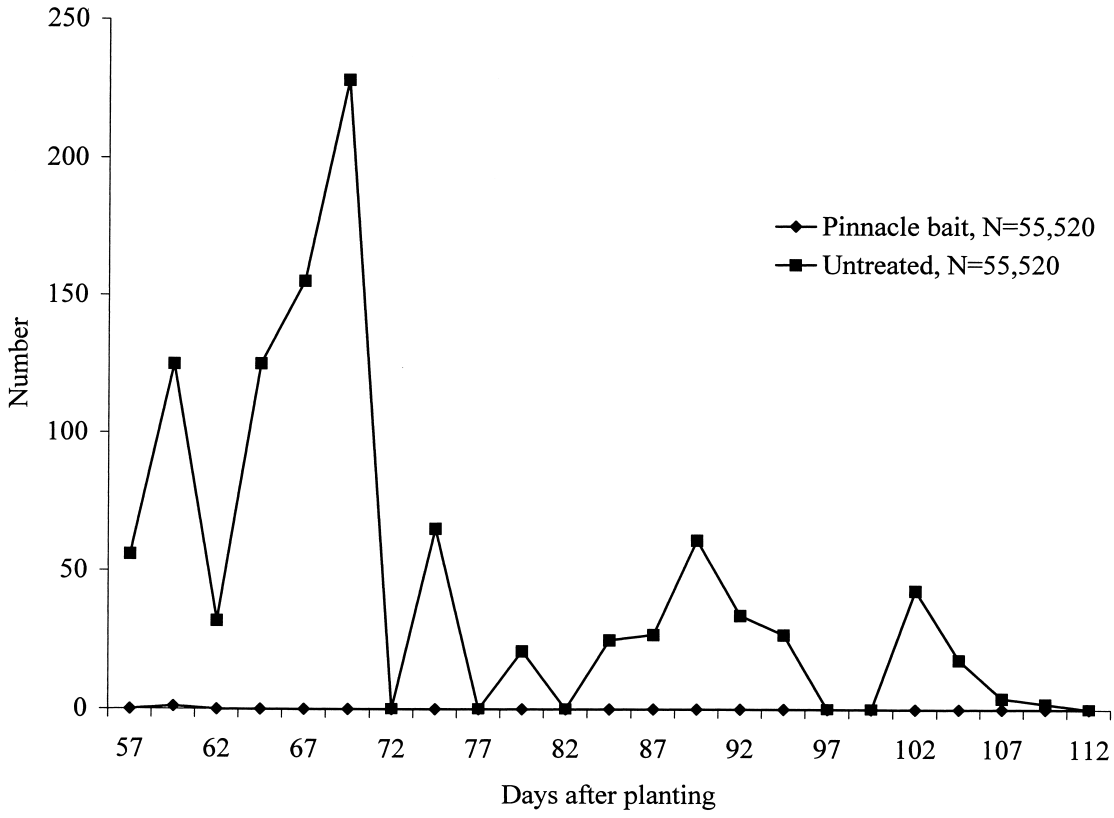

Fig. 2. Number of fruit flies collected from fallen flowers of angled luffa in plots treated with Pinnacle bait and untreated. (Only *Bactrocera diversa* was found.)

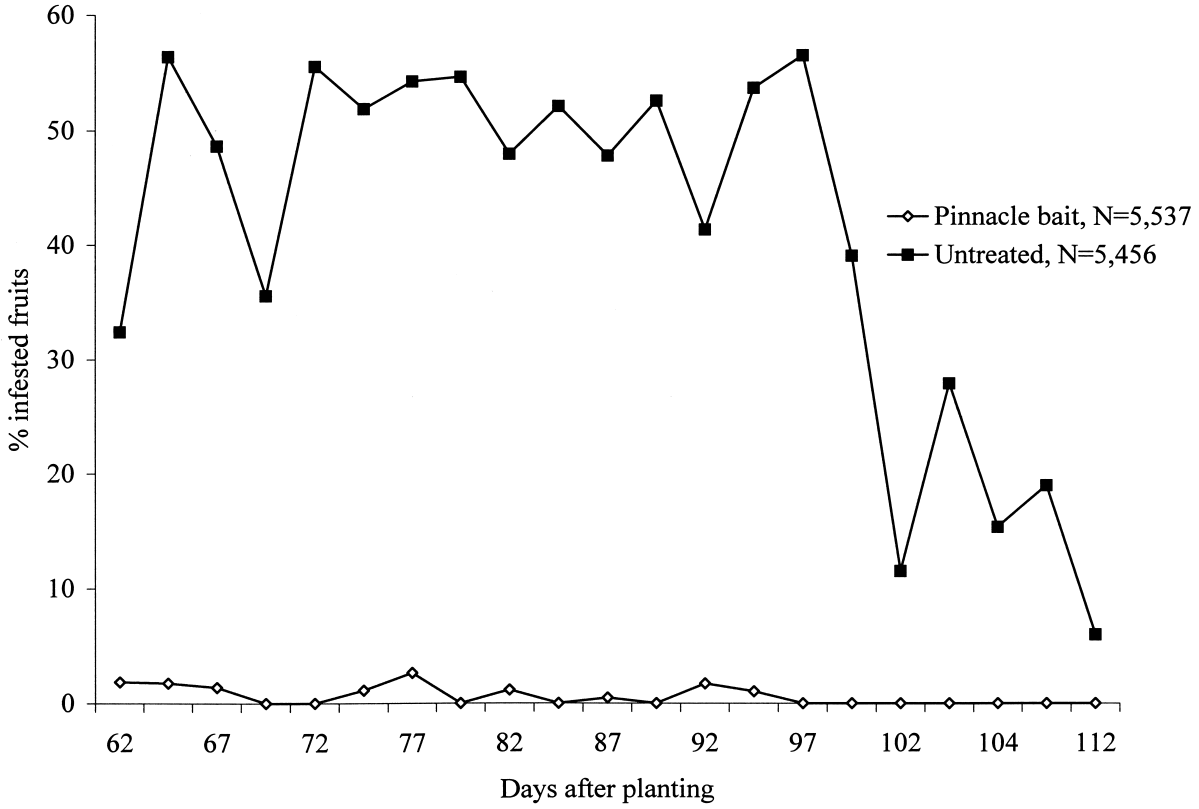

Fig. 3. Percentage of infested fruits of angled luffa in plots treated with Pinnacle bait and untreated. (Only *Bactrocera cucurbitae* and *B. tau* were found.)

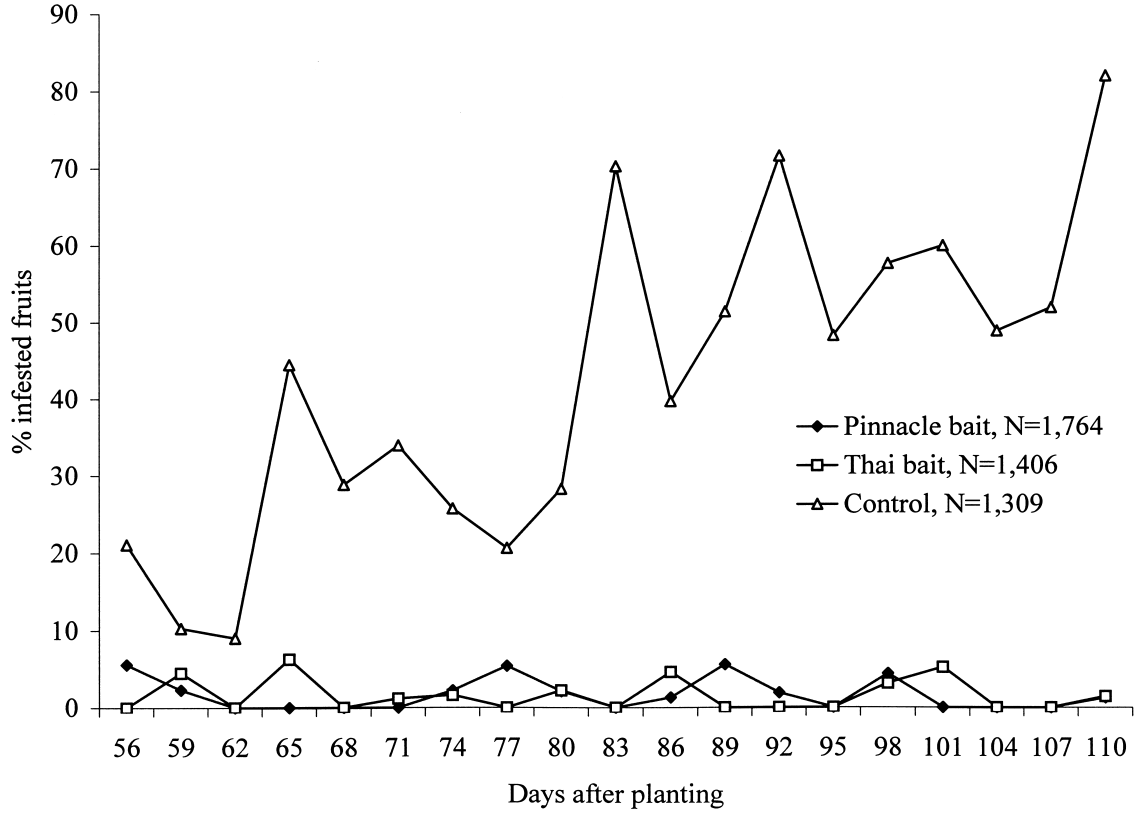

Fig. 4. Percentage of infested fruits of bitter gourd in plots treated with Pinnacle, Thai baits and untreated. (Only *Bactrocera cucurbitae* and *B. tau* were found.)

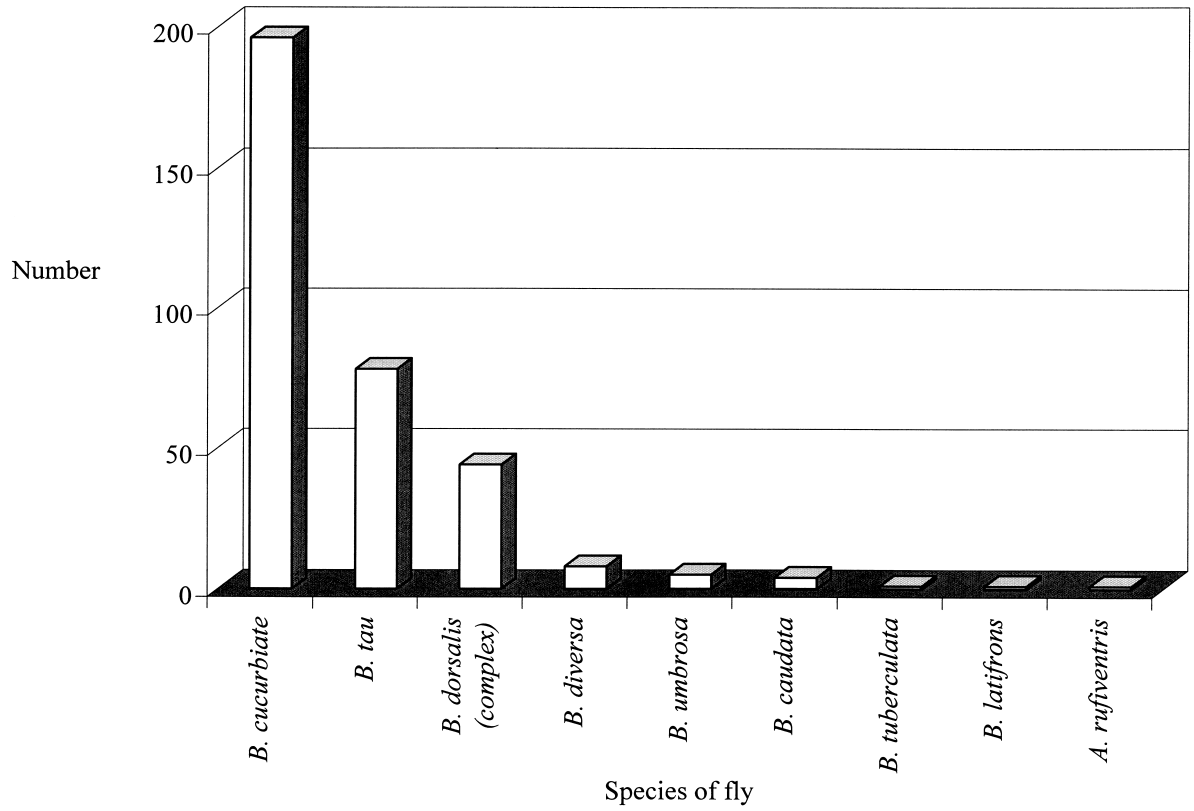

Fig. 5. Species and number of fruit fly collected from funnel traps in angled luffa plots treated with Pinnacle bait.

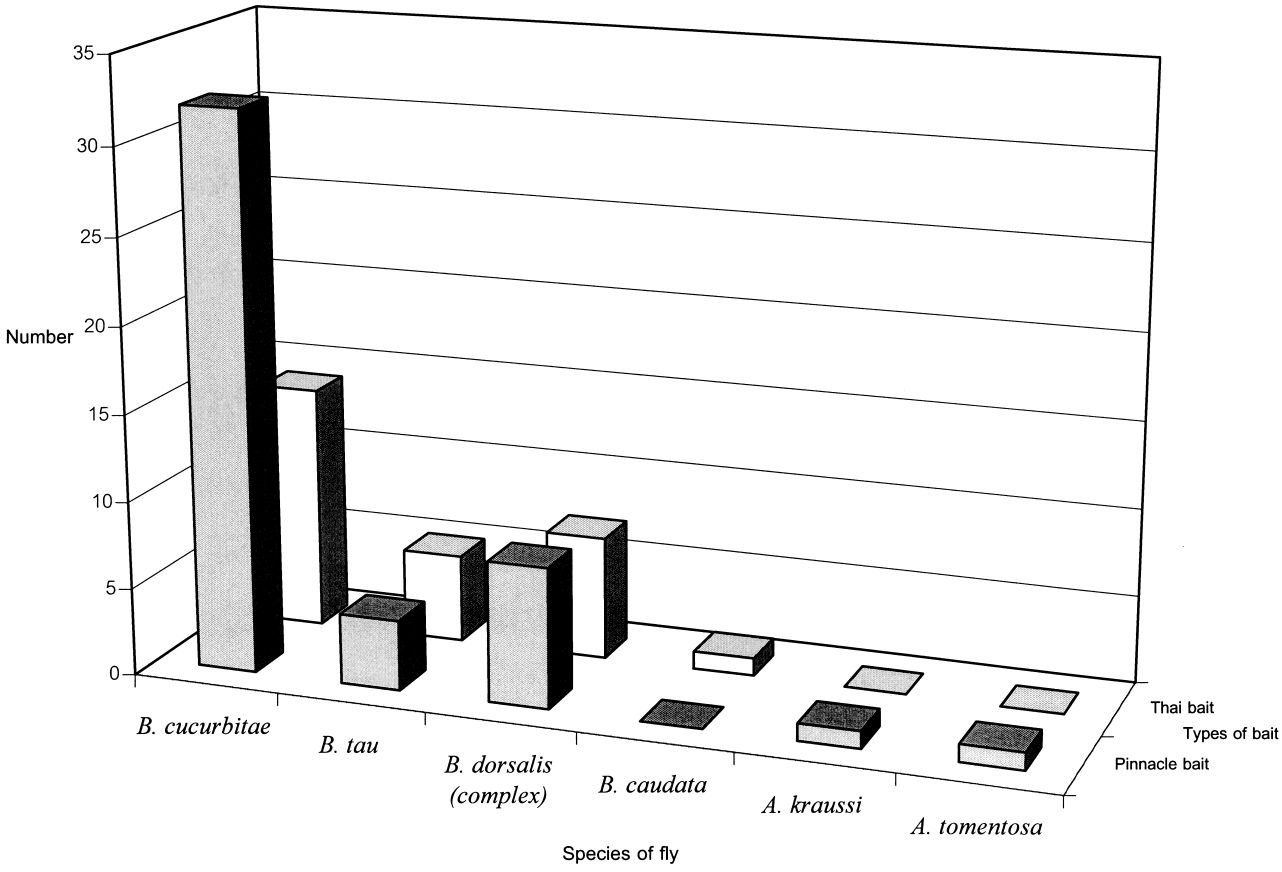

Fig. 6. Species and number of fruit fly collected from funnel traps in bitter guard plots treated with Pinnacle and the Thai baits (Both sexes were collected).

Table 1. Percent infested fruits and yields of angled luffa in plots treated with Pinnacle and untreated.

Treatment	No. of samples (N)	No. of infested fruit	% infested fruits	Yields (kg/ha)
Pinnacle	5,537	52 [1/]	0.94	302.77
Untreated	5,456	1,711 [2/]	31.36	55.81

[1/] Number of flies collected 402
[2/] Number of flies collected 38,262

1). It decreased sharply from day 102 after planting (Fig. 3). This might be due to decline in fruit numbers with the ageing of plants.

In the bitter gourd trial, protein bait treatment resulted in continuous low fruit infestation (1.59% for Pinnacle and 1.71% for Thai bait) while the untreated plot had higher infestations for the entire season (40.18%) (Fig. 4).

When marketable crop yields were measured, angled luffa produced 302.77 kg/ha under Pinnacle treatment which was 81.57 % higher than in the untreated plot (55.81 kg/ha). The treated plot also yielded lower numbers of flies in traps (402) than that in untreated plot (38,262) (Table1).

In the bitter gourd experiment, plots treated with Pinnacle and Thai bait gave 67.22% (290.85 kg/ha) and 59.98% (238.18 kg/ha) yields higher than the untreated plot (95.32 kg/ha) (Table 2).

Number and species of fruit flies obtained from funnel traps. - Similar fruit fly species were obtained from funnel traps in both trials. *B. cucurbiate* and *B. tau* were the predominant species collected (Figs. 5, 6) and these were infesting fruits of both crops (Figs. 3, 4). In the angled luffa plot treated with Pinnacle, the most abundant species caught was *B. cucurbitae*, followed by *B. tau*. The other species collected were *B. carambolae* Drew & Hancock, *B. papayae* Drew & Hancock, *B. diversa* (Coquillett), *B. umbrosa* (Fabricius), *B. caudata* (Fabricius), *B. tuberculata* (Bezzi), *B. latifrons* (Hendel) and *Adrama rufiventris* (Walker) (Fig. 5).

In the bitter gourd plot treated with Pinnacle, more *B.*

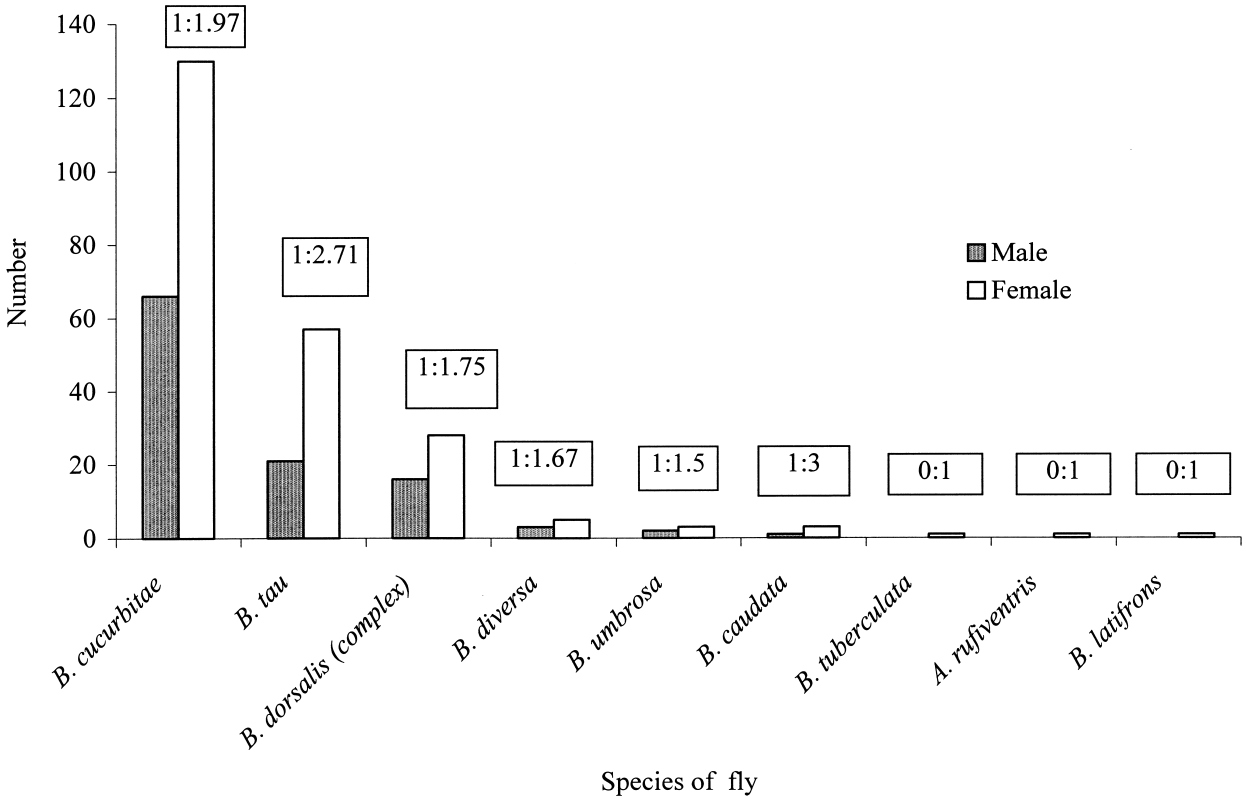

Fig. 7. Number and sex ratio of fruit fly collected from funnel traps in angled luffa plot treated with Pinnacle bait.

Table 2. Percent infested fruits and yields of bitter gourd in plots treated with Pinnacle, the Thai bait and untreated.

Treatment	No. of samples (N)	No. of infested fruit	% infested fruit	Yields (kg/ha)
Pinnacle	1,764	28 [1/]	1.59	290.85
Thai bait	1,406	24 [2/]	1.71	238.18
Untreated	1,309	526 [3/]	40.18	95.32

[1/] Number of flies collected 259
[2/] Number of flies collected 113
[3/] Number of flies collected 5,550

cucurbitae were collected from the funnel traps than *B. carambolae, B. papayae, B. tau, Anomoia kraussi* Hardy and *Acroceratitis tomentosa* Hardy (Fig. 6). In the plot treated with the Thai bait, there was a similar result except for one *B. caudata*, no *A. kraussi* and *A. tomentosa* (Fig. 6).

Number of males and females collected from funnel traps. - Generally more females than males of the pest species were trapped (Figs. 7-9). However, in the angled luffa trial only one female of each of the pest species that do not infest cucurbits, *B. tuberculata, B. latifrons and A. rufiventris* was found (Fig. 7).

Conversely, in the bitter gourd experiment, there were more males than females of *B. tau* in both types of baits (Figs. 8, 9), though females dominated in the other species. The results indicated that protein bait treatments were strong attractants for females of the pest fruit fly species when applied to host plants.

Sex ratio. - In the angled luffa trial, the sex ratio of males to females in the species caught in traps ranged from 1:2.71 to 0:1. The highest ratio was in *B. tau* (1:2.71) (Fig. 7). This result also showed that females were more attracted by the bait.

In the bitter gourd trial, the highest ratio of males to females was 1:2.56 in *B. cucurbitae* in the Pinnacle treated plot (Fig. 8) and 1:1.33 in the plot treated with Thai bait (Fig. 9).

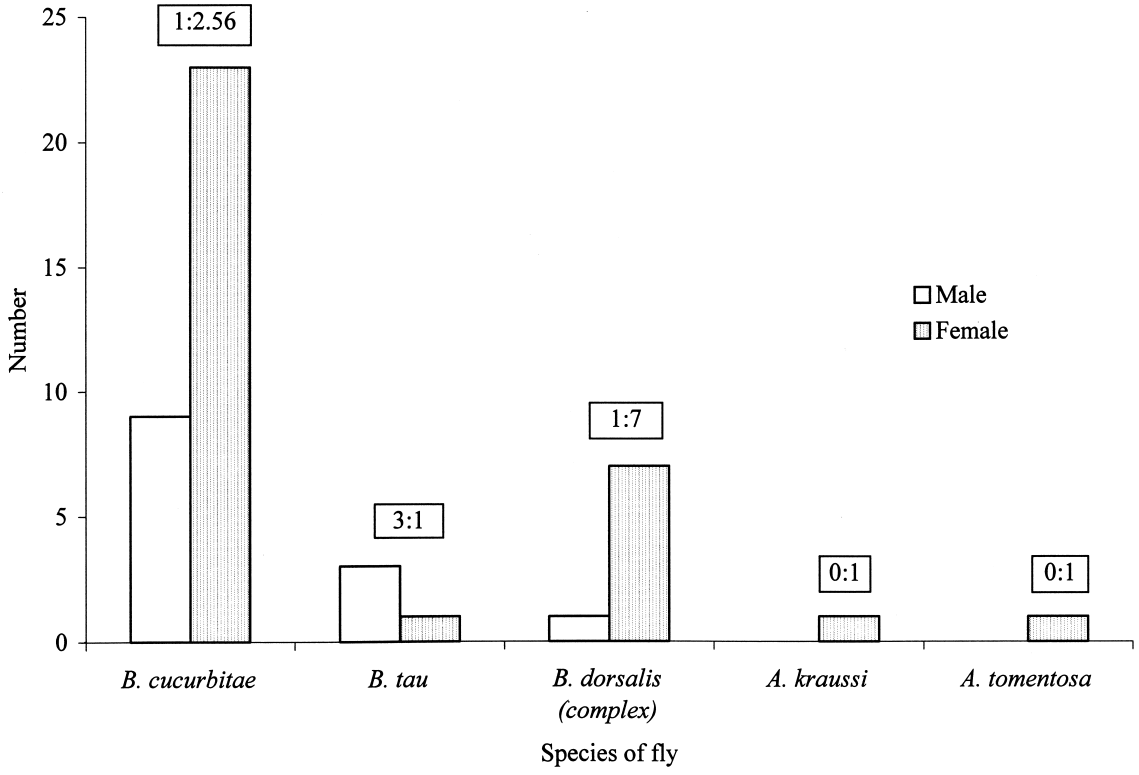

Fig. 8. Number and sex ratio of fruit fly collected from funnel traps in bitter gourd plot treated with Pinnacle bait.

CONCLUSIONS

Good control with protein bait sprays was attained in an integrated pest management (IPM) programme in Meyer lemons in a coastal district north of Brisbane (Sabine, 1992). The bait system is recognised as an integral component of IPM in horticultural crops, because it reduces pesticide levels, with a resulting beneficial result for predators, parasitoids and pollinators. Protein bait applications are also less time consuming and less demanding of labour (Smith & Nannan, 1988; Sabine, 1992).

Both types of baits i.e. Pinnacle and Thai effectively controlled infestations of *B. cucurbitae* and *B. tau* which are damaging to angled luffa and bitter gourd. It is likely that these baits could also be effective in managing infestations of fruit flies in other tropical crops.

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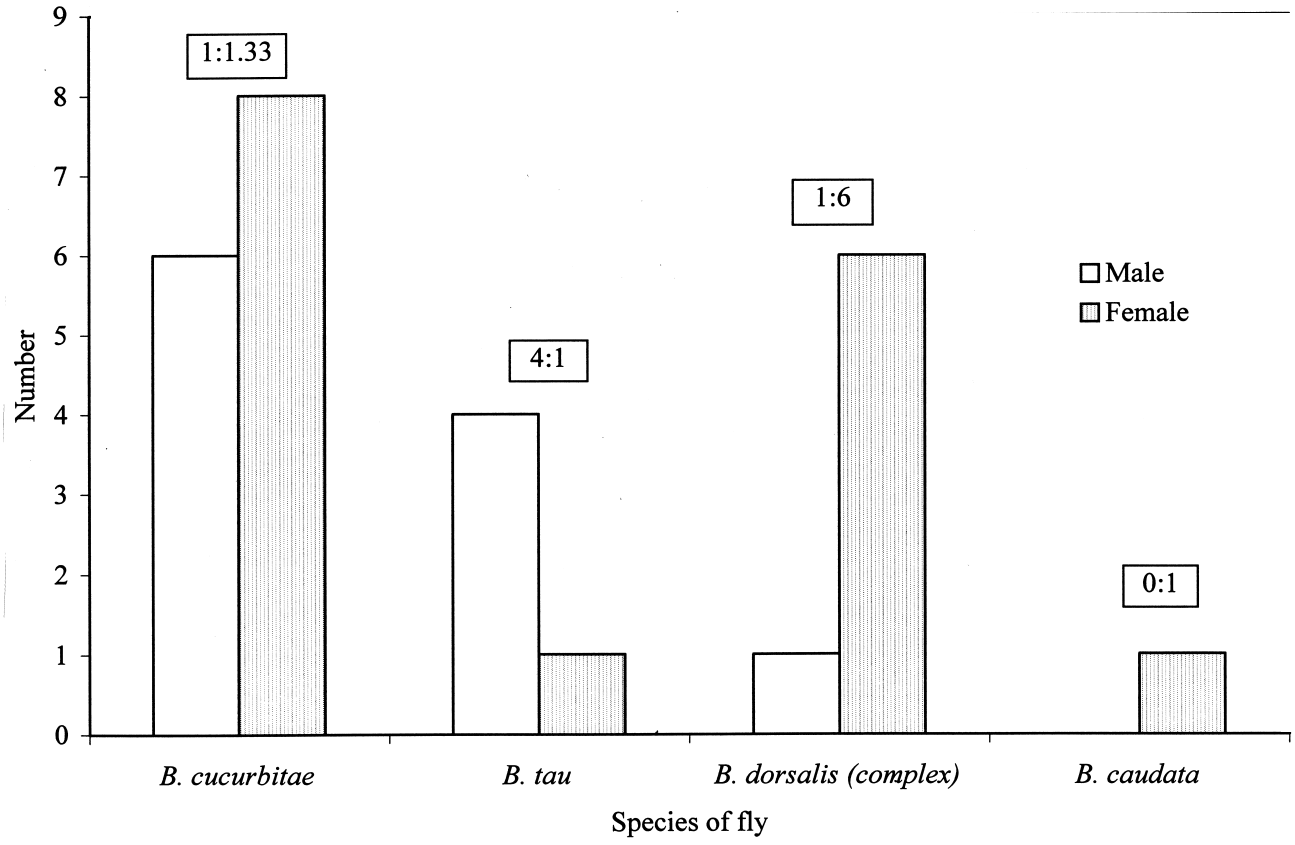

Fig. 9. Number and sex ratio of fruit fly collected from funnel traps in bitter gourd plot treated with Thai bait.

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