

**MONITORING OF FRUIT FLIES USING
DIFFERENT TYPES OF TRAPS AND LURES
IN GUAVA AND MANGO**

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**MONITORING OF FRUIT FLIES USING
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IN GUAVA AND MANGO**

*Thesis submitted to the
University of Agricultural Sciences, Dharwad
in partial fulfilment of the requirements for the
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in

AGRICULTURAL ENTOMOLOGY

By

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CERTIFICATE

*This is to certify that the thesis entitled “**MONITORING OF FRUIT FLIES USING DIFFERENT TYPES OF TRAPS AND LURES IN GUAVA AND MANGO**” submitted by Miss **RAJITHA A. R.** for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY** to the University of Agricultural Sciences, Dharwad, is a record of research work carried out by her during the period of her study in this university, under my guidance and supervision, and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.*

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SEPTEMBER, 2004


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Introduction

I. INTRODUCTION

Tephritidae is one of the largest, most diversified and fascinating acalypterate families of Dipteran insects which includes about 4000 species arranged in 500 genera (White and Elson-Harris, 1992). These are commonly called "fruit flies" due to their close association with fruits and vegetables. Of the 4000 species known, 392 species have been recorded in India (Kapoor, 1993).

Fruit flies are of great economic importance as majority of them cause extensive damage to many fruits and vegetables. They are considered as high priority quarantine pests. Because of their infestations, India has been included in the list of those countries from where fruit import to developed countries is banned. In India, a total loss of 2,558 and 26,902 million rupees was estimated due to fruit flies with and without control measures, respectively (Stonehouse, 2001).

This quartet of tiny pests can lay eggs in fruits and ruin more than 400 different fruits and vegetables including mango, guava, citrus, melon, loquat, papaya, peach, passion fruit, plum, persimmon, apple and star fruit.

Mango and guava are the two important fruit crops which are severely damaged by fruit flies. Most common species attacking these two fruits are *Bactrocera dorsalis* Hendel, *B. correcta* Bezzi and *B. zonata* (Saunders) (Verghese and Sudha Devi, 1998).

Fruit flies deposit their eggs on host fruits, when they are physiologically ripe. On hatching, maggots bore their way to the interior and feed on the pulp. Area fed by the maggot is discoloured due to rotting of the fruit and fruits drop prematurely.

Being polyphagous pests with high reproductive potential, wide host range, adaptability to climate and overlapping of generations, their management is rather difficult.

Till now, in the absence of any appropriate IPM practice, the control strategy mostly focuses on chemical insecticides which is neither safe from residue point of view nor much effective.

Sanitation combined with the use of lures and traps as well as baits proved to be one of the best alternatives for management of fruit flies. These traps have high specificity, low cost and are environmentally quite safe. In India, Rahman *et al.* (1995) discussed the role of baits and attractants in population suppression of fruit flies.

Monitoring and management of fruit flies are based on two main technologies. The first one uses parafferomone male attractants in traps that monitor male numbers and hence called male annihilation technique and the second technology is bait application technique (BAT) which relies on protein baits.

Continuous research in the development of efficient trapping systems afford several new opportunities in the efforts to control the fruit flies. Since adult fruit flies use visual and olfactory stimuli to locate hosts, traps that combine visual and olfactory cues proved to be most effective for capturing fruit flies (Epsky and Heath, 1998). Visual cues play an important role in the host finding behaviour of fruit flies (Prokopy and Owens, 1983; Fletcher and Prokopy, 1991).

The responses of the fruit flies to visual stimuli were dependent on the colour, shape and size of the stimulus (Katsoyannos, 1989). These findings have opened new avenues in increasing the efficiency of traps by altering the design and choosing the most suitable shape, size and colour.

So far, all the management strategies aimed for fruit flies, rely primarily on male annihilation technique. There are gaps in our knowledge concerning the population dynamics of female fruit flies and little information is currently available to control the female fruit flies at the farm level. Since female fruit flies are the dominant factor for

multiplication, female attractive baits are needed in any applicative system against this pest for monitoring and direct control (Mazor *et al.*, 2002).

Female fruit flies need protein source to mature sexually and also for the development of their eggs (Christenson and Foote, 1960). Hence female targeted system normally consists of traps baited with a liquid solution made from protein and fermenting sugar (Epsky *et al.*, 1999).

Protein hydrolysate lures like Nulure, Biolure, Hym-lure, Solbait, Buminal, Trece A.M. Supercharger *etc.*, are currently used for female targeted detection and monitoring program. Cornelius *et al.* (2000b) determined that liquid hydrolyzed proteinaceous bait (Nulure) attracted more female fruit flies in guava orchard.

Increased knowledge on behaviour associated with attraction of both sexually immature females and egg laying females will improve detection and delimitation of fruit flies and provide increased protection of crops adversely affected by their presence. It is envisioned that further optimization of visual cues and trap design will occur.

Further studies are needed to identify the most effective odor lure and to develop a trap design that combines visual and olfactory stimuli to maximize fruit fly captures.

Keeping these findings in view, present study on "Monitoring of fruit flies using different types of traps and lures in guava and mango" was undertaken with the following objectives.

1. To evaluate different types of traps in attracting fruit flies in guava and mango
2. To study the species complex and relative abundance of different species of fruit flies in guava and mango
3. To monitor different species of fruit flies in guava and mango
4. To evaluate protein food baits in attracting female fruit flies in guava and mango
5. To study the relationship between trap catches and weather parameters

_____ *Review of Literature*

II. REVIEW OF LITERATURE

Review of literature pertaining to efficacy of different types of traps in attracting fruit flies, species complex of fruit flies and their relative abundance, monitoring, female targeted protein food baits and relationship between trap catches and weather parameters in guava and mango are presented in this chapter.

2.1 EVALUATION OF DIFFERENT TYPES OF TRAPS IN ATTRACTING FRUIT FLIES

Fruit flies use a number of visual cues to locate hosts and appropriate visual cues may be highly attractive to these fruit flies (Prokopy, 1968).

Prokopy (1968, 1973) demonstrated that more *Rhagoletis pomonella* (Walsh) were captured on fluorescent yellow rectangles and enamel red spheres than other shapes of different colours. He hypothesized that flat surface of the rectangle represented leaf type stimulus, whereas, spheres constitute a fruit- type stimulus.

More *Ceratitis capitata* (Wiedemann) were captured on yellow rectangles than light orange, light green, red, grey or clear rectangles (Prokopy and Economopoulos, 1976).

Greany *et al.* (1977) found that fluorescent orange rectangles were the most effective for capture of Caribbean fruit fly *Anastrepha suspensa* (Loew).

Prokopy (1977) opined that 7.5 cm sticky coated red spheres attracted more *R. pomonella*.

Most of the earlier studies were concentrated on comparing the response of *R. pomonella* to different shapes. Later works on this, were diverted to many other species of Tephritids and showed that colour and shape of the stimulus helped in monitoring their population.

According to Nakagawa *et al.* (1978), 7.5 cm spheres of black and yellow colour captured more females of *C. capitata* and red, yellow and orange captured more males.

The most effective tactics developed for detecting the presence of adult blueberry maggot, *Rhagoletis mendax* Curran include baited Pherocon AM yellow sticky boards (Prokopy and Coli, 1978).

In another study, Cytrynowicz *et al.* (1982) demonstrated that yellow rectangles and yellow spheres were more attractive to *Anastrepha fraterculus* (Wiedemann) and *C. capitata* than green or red ones.

Though the use of male attractants had been one of the common procedures for monitoring, some workers opined that visual cues play an important role in host finding behaviour of fruit flies (Prokopy and Owens, 1983; Fletcher and Prokopy, 1991).

Responses of the fruit flies to visual stimuli were dependent on the colour, shape and size of the stimulus (Katsoyannos, 1989; Economopoulos, 1989).

Green, yellow and orange were the most attractive colours for the Mexican fruit fly *Anastrepha ludens* (Loew) (Robacker *et al.*, 1990). Sivinski (1990) found that more *A. suspensa* were captured on 20 cm-diameter orange spheres than spheres that were smaller or differently coloured. Bressan *et al.* (1991) found that spherical yellow traps were more attractive to *Anastrepha* spp. followed by green cylindrical traps.

Capture of oriental fruit fly, *B. dorsalis*, was higher on yellow and white 4-cm spheres than on orange, red, light green, dark green and black spheres in guava orchard (Vargas *et al.*, 1991).

Robacker (1992) opined that female Mexican fruit fly, *A. ludens* preferred large spheres over large rectangles and small rectangles over small spheres.

Stark and Vargas (1992) determined that male oriental fruit fly responded more to white and yellow coloured plastic bucket traps than green, red and black.

Epsky *et al.* (1995) found highest capture of *C. capitata* in green 3- hole traps with dull exteriors and with 12-15 cm wide visual cue than on shiny orange traps. In tests of clear traps versus traps with a painted colour strip (~7.5 cm high) around the periphery of the middle to provide a visual cue, more females and males of *C. capitata* were captured in green and yellow traps respectively (Heath *et al.*, 1995). Use of a fluorescent yellow or orange colour insert instead of white insert in Jackson traps increased *C. capitata* capture (Epsky *et al.*, 1996). Heath *et al.* (1996) observed that width of the visual cue affected percentage capture of *C. capitata* females and traps with 12-15 cm width green visual cue captured more female fruit flies. Greater captures of *C. capitata* were achieved with orange and yellow bucket traps and orange modified bucket traps (Uchida *et al.*, 1996).

Another study by Jalaluddin *et al.* (1998) revealed that orange and yellow coloured traps attracted more *Bactrocera* spp. in Tamil Nadu.

Liburd *et al.* (1998) observed that baited green, red, yellow or blue spheres were more attractive to blueberry maggot *R. mendax* than baited yellow board traps in V-orientation.

According to Cornelius *et al.* (1999) greater number of female oriental fruit flies were attracted to yellow coloured spheres and rectangular blocks of equivalent surface. Standard Ladd traps attracted more females because of the visual contrast of red spheres against a light yellow background. According to Alyokhin *et al.* (2000) Ladd trap was the most attractive visual trap for oriental fruit flies.

Liburd *et al.* (2000) demonstrated that baited 9-cm diameter sphere was more effective in capturing blueberry maggots and yellow sticky boards captured significantly more fruit flies than sticky yellow Pherocon AM boards.

Mayer *et al.* (2000) obtained more trap catch of cherry fruit fly, *R. indifferens* Curran on 10 cm red spheres followed by 8 and 12 cm, compared to vertical and V-oriented yellow rectangles.

Katsoyannos and Kouloussis (2001) revealed that yellow and orange 70-mm-diameter plastic spheres, coated with adhesive, trapped the greatest number of male *B. oleae* (Gmelin) while red and black spheres trapped more females.

In another study conducted in Bangalore, Madhura (2001) found that deep yellow colour attracted maximum number of *Bactrocera* spp. and higher numbers were trapped in tree shaped trap followed by lotus and sphere shaped traps.

Robacker and Heath (2001) opined that yellow sticky traps without mesh captured six times more Mexican fruit flies than green traps.

Sarada *et al.* (2001a) observed that significantly more number of *B. dorsalis*, *B. correcta* and *B. zonata* were attracted to white (16.95 flies/trap) and yellow (15.31 fruit flies/trap) coloured traps followed by green, orange, red and blue, respectively.

Smith *et al.* (2001) found that Phero Tech Rhagoletis traps were more efficient than the conventional Pherocon AM traps for monitoring apple maggot, *R. pomonella*.

In various trap designs, IIHR and open pan trap attracted significantly more number of *Bactrocera* spp. (Madhura and Viraktamath, 2003).

2.2 SPECIES COMPLEX AND RELATIVE ABUNDANCE OF DIFFERENT SPECIES OF FRUIT FLIES IN GUAVA AND MANGO

2.2.1 Guava

According to a survey conducted by Narayanan and Batra (1960) in Indian sub-continent, four species of fruit flies namely, *B. dorsalis*, *B. zonata*, *B. cucurbitae*

(Coquillett) and *B. diversa* Coq. caused enormous damage to guava. However, Bhat (1989) recorded only *B. dorsalis* infesting guava at Bangalore.

Kapoor (1993) studied extensively on Indian fruit flies and reported *B. dorsalis*, *B. zonata*, *B. diversa* and *B. cucurbitae* infesting guava.

B. dorsalis and *B. zonata* are the most important pests of guava in Pakistan (Qureshi and Hussain, 1993).

Veenakumari *et al.* (1996) recorded *B. carambolae* (Drew and Hancock) infesting guava in the Andaman islands.

Ranganath and Veenakumari (1996) surveyed the Andaman Islands and reported two species namely *B. carambolae* and *B. albistrigata* (de Meijere) infesting guava.

Ramani (1997) reported six species of fruit flies namely *B. albistrigata*, *B. carambolae*, *B. caryeae* (Kapoor), *B. dorsalis*, *B. versicolor* (Bezzi) and *B. zonata* from Karnataka and Andaman and Nicobar islands.

Jalaluddin *et al.* (1999) recorded three species of fruit flies infesting guava from Tamil Nadu which included, *B. correcta*, *B. dorsalis* and *B. zonata*.

Chaudhry and Jamal (2000) recorded *B. dorsalis* and *B. zonata* infesting guava in Pakistan.

Clarke *et al.* (2001) reported species of *B. dorsalis* complex and *B. correcta* from Northern and Central Thailand infesting guava.

Suresh Babu (2002) reported three species of fruit flies *B. zonata*, *B. correcta* and *B. dorsalis* associated with guava from Dharwad, Karnataka.

2.2.2 Mango

According to Narayanan and Batra (1960), *B. dorsalis*, *B. zonata*, *B. correcta* and *B. diversa* cause lot of damage to mango crop in India.

B. correcta was a serious pest of mango causing qualitative loss under south Gujarat conditions (Shah and Vora, 1974 and Sushilkumar *et al.*, 1997).

In Indonesia, *B. dorsalis*, *B. cucurbitae* and *B. umbrosa* Fab. caused more economic damage to mango orchards (Singgih, 1991).

According to Vijaysegaran and Osman (1991) *Bactrocera* Taxon A, *Bactrocera* Taxon B, *B. cucurbitae*, *B. umbrosa*, *B. latifrons* (Hendel) and *B. tau* Walker caused considerable damage to mango orchards.

Kapoor (1993) reported *B. correcta*, *B. dorsalis*, *B. diversa*, *B. caudata* Fab. and *B. tau* infesting mango.

Qureshi and Hussain (1993) reported *B. zonata* and *B. correcta* causing serious threat to mango orchards in Pakistan.

According to Ranganath and Veenakumari (1996) *B. carambolae* infested mango in Andaman islands.

Ramani (1997) recorded five species of fruit flies infesting mango from Andaman and Nicobar islands and Karnataka, from methyl eugenol and cue lure baited traps. These included *B. carambolae*, *B. caryeae*, *B. correcta*, *B. dorsalis* and *B. zonata*.

Anjum *et al.* (2000) reported *B. dorsalis* and *B. zonata* causing serious threat to the mango orchards in Pakistan.

In Mauritius, Gopaul *et al.* (2000) reported three species of fruit flies namely *B. zonata*, *C. rosa* Karsch and *B. cucurbitae* attracted to Mc Phail traps in mango orchard.

Madhura (2001) recorded 14 species of fruit flies at Bangalore in traps baited with methyl eugenol, cuelure, mixture of methyl eugenol and cuelure and plant extract. The fruit flies recorded were *B. affinis* (Hardy) *B. caryeae*, *B. correcta*, *B. dorsalis*, *B. latifrons*, *B. nigrotibialis* (Perkins), *B. verbascifoliae* (Drew and Hancock), *B. zonata*, *B. trilineata* (Hardy), *B. diversa*, *B. cucurbitae*, *B. gavis* (Monro), *Dacus* (Callantra) sp. and *Bactrocera* (*Bactrocera*) sp. Similarly, Ingoley *et al.* (2002) reported *B. cucurbitae* from cuelure traps.

Sushilkumar *et al.* (2002) assessed the crop losses due to *B. correcta* to commercial varieties of mango in Gujarat and concluded that *B. correcta* caused the highest economic loss in Alphonso followed by Kesar variety.

According to Dwivedi *et al.* (2003), *B. dorsalis* infested mango in Uttar Pradesh. Suresh Babu and Viraktamath (2003) reported three species of fruit flies viz., *B. zonata*, *B. correcta* and *B. dorsalis* at Dharwad in methyl eugenol baited traps.

2.3 MONITORING OF DIFFERENT SPECIES OF FRUIT FLIES IN GUAVA AND MANGO

2.3.1 Guava

Narayanan and Batra (1960) observed peak incidence of fruit flies from July to September. Prasad and Bagle (1978) observed that *B. dorsalis* had two peaks of incidence on guava from March to April and August to September in Bangalore. Similarly, Belavadi (1979) reported high trap catches of *B. dorsalis* from March to May and September to November.

Liu *et al.* (1985) observed a decline in *B. dorsalis* population from November to early May under Taiwan conditions. According to Vargas *et al.* (1989) peak incidence of *B. dorsalis* occurred from April to June and September to December in Hawaii.

In China, Chen *et al.* (1995) recorded a peak in *B. dorsalis* population from July to November. Hwang *et al.* (1997) observed a peak incidence of *B. dorsalis* population from June to September, while decrease in population was observed during winter.

Makhmoor and Singh (1998) observed peak population of *B. dorsalis* from July to August, 1992 with maximum trap catch of 170.66 fruit flies/trap in July at Jammu.

Jalaluddin *et al.* (1999) observed three peaks of *B. zonata*, *B. correcta* and *B. dorsalis* in Tamil Nadu. The first peak occurred during 2nd fortnight of June, 2nd peak during 2nd fortnight of July and 3rd peak during 2nd fortnight of August.

Maximum trap catch of *B. dorsalis* and *B. zonata* was 427.2 and 517.0 fruit flies during 37th and 39th standard weeks, respectively, in guava orchard at Himachal Pradesh (Gupta and Bhatia, 2000).

According to Chaudhry and Jamal (2000) the peak activity of *B. dorsalis* and *B. zonata* was observed from August to October, which coincided with the maturity of guava.

Clarke *et al.* (2001) observed that *B. dorsalis* and *B. correcta* exhibited unimodal patterns of population abundance with maximum populations between June and September in guava.

Jalaluddin *et al.* (2001) studied population fluctuations of *B. correcta* in guava orchards in Tamil Nadu from May 1994 to September 1995 using methyl eugenol traps. They observed a distinct population peak, which coincided with the ripening of fruits from July to August in both years.

Sarada *et al.* (2001b) studied seasonal incidence and population fluctuation of *Bactrocera* sp. in guava during September 1999 to March 2000. In 1999, peak population (223.5 fruit flies) was observed during 4th week of November while lowest population (11.0 fruit flies) was reached during the first week of March 2000.

Suresh Babu (2002) observed major peak of *B. dorsalis* during 45th standard week and peak catch of *B. correcta* during 46th standard week in 2001. Population of *B. zonata* was recorded throughout the year with a peak population during 44th standard week in 2001 and during 9th standard week in 2002. Peak catch was observed during 21st and 46th standard week, when the total number of fruit flies was considered.

2.3.2 Mango

Bagle and Prasad (1983) observed that the population of *B. dorsalis* was maximum during March, April, May and June with average monthly trap catches of 1268, 270, 416 and 487 fruit flies/trap, respectively. The lowest catch was recorded during January, August and December with average monthly trap catches of 42, 71 and 72 fruit flies/trap, respectively.

In China, Chiu and Chu (1986) recorded a peak in *B. dorsalis* population from June to September and an increase in population was observed during April while decrease was observed from December to March.

Mann (1996) studied the population dynamics of *B. dorsalis* in a mango orchard in Punjab. He observed that population counts were low in winter months from December and February due to low temperature. Low catches were observed in July.

Sushilkumar *et al.* (1997) found that trapping of *B. correcta* peaked during 2nd fortnight of April (453 fruit flies/trap) and May (483 fruit flies/trap) and thereafter the population declined gradually. Major activity of the pest occurred from March to June coinciding with the fruiting period of the crop. Kumar *et al.* (1997) reported three peaks of *B. correcta* at Gujarat.

Verghese and Sudha Devi (1998) studied the relationship between trap catch of *B. dorsalis* with abiotic factors during 1995 and 1996. In 1995, a peak population was

observed in June followed by a minor peak in August. But in 1996, peak population occurred in May and August coinciding with the active breeding of fruit flies and another peak during September and November synchronizing with the guava season during November.

Agarwal *et al.* (1999) studied the trap catches of *B. dorsalis* and *B. zonata* using methyl eugenol traps from April to August, 1997, in Bihar. The average number of fruit flies trapped was 39.94 and 134.92 fruit flies per trap per week, respectively. The average mean population of *B. zonata* was 3.38 times greater than that of *B. dorsalis*.

Agarwal and Kumar (1999b) studied the population buildup of peach fruit fly *B. zonata* from April to August, 1997, in North Bihar. During 3rd week of June, highest trap catches were recorded (357.0 fruit flies/trap) while lowest trap catches were noticed in last week of August (14.3 fruit flies/trap).

Anjum *et al.* (2000) reported that population of *B. zonata* was higher than that of *B. dorsalis* and the highest population was observed in first week of July.

Gupta and Bhatia (2000) reported that maximum catch of *B. dorsalis* and *B. zonata* was 98.6 and 62.6 fruit flies/trap during 30th and 27th standard week in 1992 and 1993, respectively, in mango orchards in Himachal Pradesh.

Seewooruthun *et al.* (2001) studied the weekly trap catches of *B. dorsalis* at Mauritius in mango. Peak activity was observed in the month of June followed by two small peaks in July and September. In case of *B. zonata*, peak population build up was observed during April-June.

Madhura (2001) studied the seasonal activity of fruit flies during 1998-2000. In 1998, peak population was observed during 3rd week of May (315.14 fruit flies/week). During 1999, two peaks were observed. The first peak was during 3rd week of May

(282.29 fruit flies/week) and the 2nd peak during 3rd week of June (182.43 fruit flies/week). In 2000, increase in population commenced from 4th week of April and peak population was observed during 3rd week of May (1318 fruit flies/week)

Sarada *et al.* (2001b) worked out the seasonal abundance and population fluctuation of fruit flies in mango in Chittoor district from February to July 2000. Peak population was observed from May to June in mango coinciding with fruit maturity period. However a gradual increase was observed from first week of February (34 fruit flies) to 5th week of June, 2000 (235 fruit flies).

B. dorsalis was first observed in April with three per cent infestation which gradually increased in May (8.2%) and June (9.8%) and then slightly declined in July (8.3%) in mango orchards at Kanpur (Dwivedi *et al.*, 2003).

Suresh Babu and Viraktamath (2003) reported one major peak of *B. zonata* (21st week), three peaks of *B. correcta* (19, 23 and 47th weeks) and three peaks of *B. dorsalis* (21, 23 and 46th weeks) at Dharwad.

2.4 EVALUATION OF PROTEIN FOOD BAITS IN ATTRACTING FEMALE FRUIT FLIES

Some of the earliest trapping systems for fruit flies relied on the use of baits made from proteins and fermenting sugar (Gurney, 1925).

Food baits derived from hydrolyzed proteins such as yeast, corn or soybran are generally attractive to oriental fruit fly, *B. dorsalis* and melon fly, *B. cucurbitae* (Steiner 1952).

According to Christenson and Foote (1960) female fruit flies require protein source to ensure fecundity.

Narayanan and Batra (1960) recommended spraying of protein hydrolysate, brown sugar and malathion on foliage against the population of oriental fruit fly and melon fly.

According to Kumar *et al.* (1976) a treatment consisting of jack fruit pulp, citronella oil and malathion was observed significantly superior in attracting *B. cucurbitae*.

Vijaysegaran (1985) reported that spraying of 0.2 per cent (AI) Staley's Protein Insecticide bait No 7 (PIB-7) + 0.2 per cent (AI) malathion was effective against melon fly.

Bait mixtures of carbohydrates and other fermenting substances such as molasses, sugar *etc.* in combination with inorganic insecticides were used as attractants for fruit flies and corn protein hydrolysate was found to be more effective against *C. capitata* (Roessler, 1989).

Robacker *et al.* (1990) opined that yeast hydrolysate in green and yellow traps was more efficient in attracting *A. ludens*.

Wakabayashi and Cunningham (1991) prepared a four component mixture consisting of ammonium bicarbonate, linolenic acid, putrescine and pyrrolidine which attracted melon fly, *B. cucurbitae*.

Liu and Chen (1992) observed that protein hydrolysate was the most effective bait attracting 45.4 per cent of adult females of *B. dorsalis*. Other protein baits, PIB-7 and Nu-lure at a pH of 10 also attracted more female fruit flies.

Anastrepha sp. was attracted more to yeast hydrolysate (Heath *et al.*, 1993). Ammonia derived baits including AMPu (a blend of ammonium bicarbonate, methylamine hydrochloride and putrescine) were effective in attracting Mexican fruit fly, *A. ludens* (Robacker and Warfield, 1993).

Heath *et al.* (1995) developed a female targeted trapping system including food based synthetic lures of ammonium acetate and putrescine (Biolure) in attracting Mediterranean and Mexican fruit flies, *A. ludens* and *C. capitata*

Liu and Chang (1995) observed that various protein sources like yeasts, peptones, molasses and tryptone along with ethyl acetate was effective in attracting *B. cucurbitae*

Rahman *et al.* (1995) suggested the use of protein hydrolysate, methyl eugenol and malathion for population suppression of *B. dorsalis*.

AMPu was as effective as Torula yeast in attracting Mexican fruit fly, *A. ludens* according to Robacker (1995).

A combination of three food attractants, ammonium acetate, trimethylamine and putrescine, loaded in long lasting dispensers in McPhail traps was found to be very effective for adult *C. capitata* females (Epsky *et al.*, 1995; Heath *et al.*, 1995; Katsoyannos *et al.*, 1999).

According to Allwood (1997) protein bait acted as a food attractant to immature female fruit flies and yeast autolysate proved to be the most attractive bait.

Heath *et al.* (1997) found that addition of trimethylamine to traps baited with ammonium acetate and putrescine further increased the capture of female *C. capitata* in cylindrical dry traps and in McPhail traps.

Bakri *et al.* (1998) observed that cylindrical dry traps baited with the 2-component synthetic lure (ammonium acetate and putrescine) captured more females than males in Morocco.

Epsky and Heath (1998) concluded that ammonia is used by several species of fruit flies to locate food and/or oviposition resources.

In Israel, International Pheromone McPhail Trap (IPMT) baited with the 3-component synthetic lure captured approximately two times more female fruit flies than males in citrus (Gazit *et al.*, 1998).

Pherocon AM traps baited with ammonium acetate and protein hydrolysate captured significantly more *R. mendax* fruit flies (Liburd *et al.*, 1998).

Jaggery was found to be the best food attractant for *B. tau* followed by the mixtures of ethyl methyl ketone + ammonium acetate, ethyl methyl ketone + sugar, sugar + ethyl methyl ketone + ammonium acetate + water (Sood and Nath, 1998).

In a study conducted at Pusa, Vinod Kumar and Agarwal (1998) reported that mango pulp + malathion attracted maximum *B. dorsalis*.

Agarwal and Kumar (1999a) found that treatment comprising methyl eugenol, mango pulp and malathion, resulted in maximum trapping of *B. zonata* (164.52 flies/trap/week) at Pusa. Combination of protein hydrolysate, methyl eugenol and malathion attracted 151.74 fruit flies/trap/week.

Katsoyannos *et al.* (1999) found that IPMT traps baited with the synthetic 3-component lure was most effective in capturing female *C. capitata*.

Epsky *et al.* (1999) reported that female *C. capitata* targeted system consisted of McPhail trap baited with a liquid solution made from proteins and fermenting sugar.

According to Alyokhin *et al.* (2000) protein odor significantly increased the number of oriental fruit flies captured by Ladd traps.

Cornelius *et al.* (2000b) determined that liquid hydrolyzed proteinaceous bait (Nu lure) attracted more female oriental fruit flies in guava orchard than several ammonia based olfactory lures and spheres baited with either supercharger or Biolure captured more female oriental fruit flies than unbaited spheres.

Females of *B. dorsalis* were more attracted to odors of soft ripe fruit and McPhail traps baited with mango captured equal number of female fruit flies as McPhail traps baited with protein odor. (Cornelius *et al.* 2000a).

Madhura (2001) found that papaya and guava baited traps attracted significantly more *Bactrocera* spp. at Bangalore.

Boscan de Martinez *et al.* (2001) observed hydrolysed protein Nulure (9%) + borax was effective in capturing *Anastrepha* sp. and *C. capitata*.

Sar *et al.* (2001) reported that in Papua New Guinea, protein bait spraying reduced amount of infestation or damage due to *B. frauenfeldi* (Schiner) in carambola from 98 per cent to 1 per cent.

Bait mixtures containing boric acid and protein hydrolysate proved to be most effective against *B. tau* (Sunandita and Gupta, 2001).

According to Thomas *et al.* (2001) open bottom plastic traps baited with a two component synthetic lure (ammonium acetate and putrescine) caught more female fruit flies than McPhail traps baited with *Torula* yeast.

Broughton and Francis de Lima (2002) observed that Biolure outperformed the female targeted system currently used for monitoring female *C. capitata* (liquid protein in Mc Phail trap).

Montiel and Jones (2002) recommended protein bait spraying with sprayable protein (1 ml of protein hydrolysate) against *B. oleae*.

According to Montoya *et al.* (2002) McPhail traps baited with liquid hydrolysed protein found to be very effective in attracting *A. oblique* (Macquart) and *A. ludens*.

Satpathy and Samarjit Rai (2002) found that over-ripe banana pulp containing yeast as protein source and sugar, attracted significantly more *B. cucurbitae*.

Fabre *et al.* (2003) evaluated the attractiveness of commercially available protein hydrolysate baits and found Solbait more attractive to female melon flies.

According to Ros *et al.* (2003) the hydrolysed protein (Nulure 9%) was the best attractant against *B. oleae*.

Spheres baited internally or externally with three component food attractant containing ammonium acetate, 1,4-diaminobutane (putrescine) and trimethylamine (FA-3) were more attractive for female *C. capitata* than unbaited ones (Katsoyannos and Papadopoulos, 2004).

2.5 RELATIONSHIP BETWEEN TRAP CATCHES AND WEATHER PARAMETERS

2.5.1 Guava

According to Shukla and Prasad (1985) the peaks of *B. dorsalis* had significant correlation with maximum and minimum temperature and maximum relative humidity. Trap catches were significantly correlated with minimum relative humidity. They observed a negative correlation between weekly rainfall and number of *B. dorsalis* captured and positive correlation between weekly average number of day light hours and catches of *B. dorsalis* and low negative correlation between weekly wind velocity and number of *B. dorsalis* trapped.

Makhmoor and Singh (1998) observed that temperature had negative correlation with trap catches while relative humidity and rainfall had positive correlation with *B. dorsalis* population.

Gupta and Bhatia (2000) found a significant positive correlation between trap catches of *B. dorsalis* and *B. zonata* with maximum and minimum temperature.

Jalaluddin *et al.* (2001) revealed that population of *B. correcta* showed significant positive correlation with mean maximum temperature, minimum temperature, day-degrees, morning relative humidity and rainfall. Weekly mean sunshine hours had low negative correlation with the trap catch.

Sarada *et al.* (2001b) found that fruit fly population had positive correlation with maximum temperature, and with minimum temperature, the correlation was positive and non-significant.

According to Suresh Babu (2002), *B. zonata* and *B. correcta* had significant positive correlation with maximum temperature and high significant negative correlation with minimum relative humidity at Dharwad. At Kumbapur, both the species had positive correlation with maximum temperature and relative humidity.

2.5.2 Mango

Bagle and Prasad (1983) observed a significant positive correlation between weekly trap catch of *B. dorsalis* and maximum temperature while negative correlation was observed between weekly catch and relative humidity, rainfall and wind velocity.

Agarwal *et al.* (1995) observed a significant positive correlation between trap catches of *B. dorsalis* and maximum and minimum temperature.

Sushilkumar *et al.* (1997) found that the population variations of *B. correcta* were positively correlated with maximum and minimum temperature while rainfall, sunshine hours and relative humidity did not show any significant impact on population variation.

Vergheese and Sudha Devi (1998) observed that trap catches of *B. dorsalis* showed significant positive correlation with minimum temperature and wind speed.

Agarwal and Kumar (1999b) found positive correlation between *B. zonata* population and maximum and minimum temperature and rainfall, while, negative correlation was obtained between trap catches and relative humidity.

According to Madhura (2001), population of fruit flies showed non-significant correlation with maximum temperature during 1998, significant negative correlation during 1999 and significant positive correlation during 2000. Relative humidity had negative correlation during 1998 and 2000 and positive correlation during 1998.

Sarada *et al.* (2001b) observed that fruit fly population was positively correlated with minimum temperature and rainfall whereas with relative humidity it was negative. Relationship was positive and nonsignificant with maximum temperature.

According to Suresh Babu and Viraktamath (2003), *B. zonata* and *B. correcta* had significant positive correlation with minimum temperature at Dharwad, while at Kumbapur, both the species had positive correlation with maximum temperature and minimum temperature.

Shekharappa *et al.* (1998), Madhura (2001) and Suresh Babu and Viraktamath (2003) opined that population fluctuation of fruit flies depends on the availability of host crops.

Material and Methods

III. MATERIAL AND METHODS

Various materials used and the methods adopted to evaluate the efficacy of different types of traps, to study species complex of fruit flies and their relative abundance, monitoring, evaluation of protein food baits and relationship between trap catches and weather parameters are presented in this chapter.

3.1 EVALUATION OF DIFFERENT TYPES OF TRAPS IN ATTRACTING FRUIT FLIES IN GUAVA AND MANGO

Following three experiments were carried out at three different locations under this objective.

3.1.1 Experiment-1: Evaluation of different types of traps in attracting fruit flies in guava and mango orchard at Dharwad

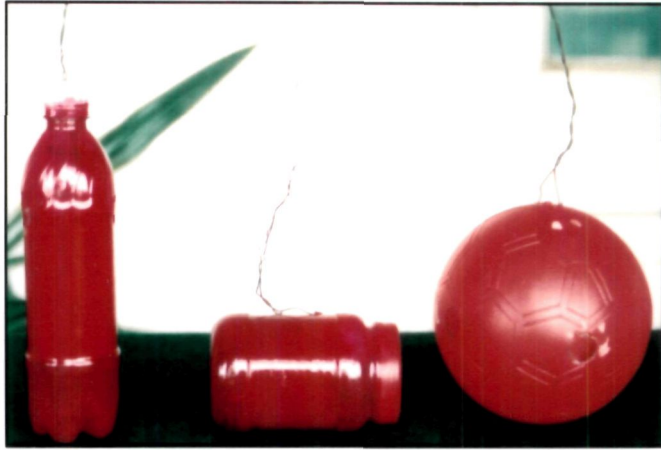
This study was carried out in guava (2.5 acres) and mango orchards (5.5 acres) of the University of Agricultural Sciences (UAS), Dharwad from July 2003 to April 2004.

A total of 36 traps which differed in shape, size and colour were set up in each of guava and mango orchard separately (Plate 1 and Plate 2). Each trap had four holes of 20 mm size on four sides and a cotton wad charged with 0.4 ml methyl eugenol and 1 ml of dichlorvos, placed inside the trap in a loop made of iron wire. Each trap was serviced with these chemicals at monthly and weekly intervals, respectively. Care was taken to maintain a distance of 50 m between the two traps to avoid trap interference and the position of traps was randomly changed at fortnight intervals to nullify the effect of position of trap in attracting fruit flies.

These traps were treated as 36 treatments and the details of the traps are given in table 1.

Table 1. Details of different types of traps studied for their efficacy

Treatment	Description of the trap	Size	Abbreviation used	Referred in text as
T ₁	Bottle-Transparent	250 ml	BT1	Small
T ₂	Bottle-Red	250 ml	BR1	
T ₃	Bottle-Green	250 ml	BG1	
T ₄	Bottle-Orange	250 ml	BO1	
T ₅	Cylinder-Transparent	250 ml	CT1	Small
T ₆	Cylinder-Red	250 ml	CR1	
T ₇	Cylinder-Green	250 ml	CG1	
T ₈	Cylinder-Orange	250 ml	CO1	
T ₉	Sphere-Transparent	10 cm diameter	ST1	Small
T ₁₀	Sphere-Red	10 cm diameter	SR1	
T ₁₁	Sphere-Green	10 cm diameter	SG1	
T ₁₂	Sphere-Orange	10 cm diameter	SO1	
T ₁₃	Bottle-Transparent	500 ml	BT2	Medium
T ₁₄	Bottle-Red	500 ml	BR2	
T ₁₅	Bottle-Green	500 ml	BG2	
T ₁₆	Bottle-Orange	500 ml	BO2	
T ₁₇	Cylinder-Transparent	500 ml	CT2	Medium
T ₁₈	Cylinder-Red	500 ml	CR2	
T ₁₉	Cylinder-Green	500 ml	CG2	
T ₂₀	Cylinder-Orange	500 ml	CO2	
T ₂₁	Sphere-Transparent	15 cm diameter	ST2	Medium
T ₂₂	Sphere-Red	15 cm diameter	SR2	
T ₂₃	Sphere-Green	15 cm diameter	SG2	
T ₂₄	Sphere-Orange	15 cm diameter	SO2	
T ₂₅	Bottle-Transparent	1000 ml	BT3	Big
T ₂₆	Bottle-Red	1000 ml	BR3	
T ₂₇	Bottle-Green	1000 ml	BG3	
T ₂₈	Bottle-Orange	1000 ml	BO3	
T ₂₉	Cylinder-Transparent	1000 ml	CT3	Big
T ₃₀	Cylinder-Red	1000 ml	CR3	
T ₃₁	Cylinder-Green	1000 ml	CG3	
T ₃₂	Cylinder-Orange	1000 ml	CO3	
T ₃₃	Sphere-Transparent	20 cm diameter	ST3	Big
T ₃₄	Sphere-Red	20 cm diameter	SR3	
T ₃₅	Sphere-Green	20 cm diameter	SG3	
T ₃₆	Sphere-Orange	20 cm diameter	SO3	

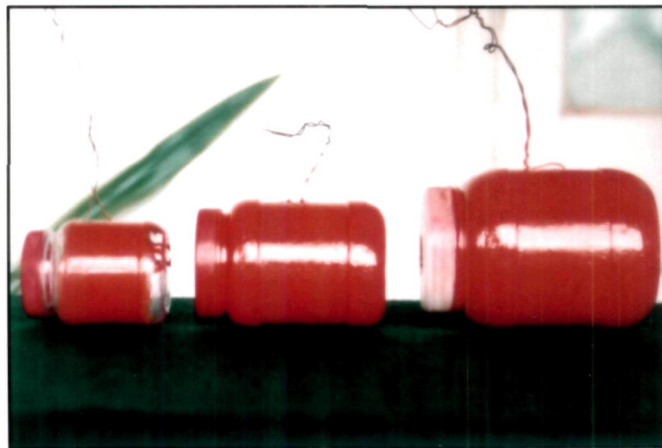


Bottle

Cylinder

Sphere

Shapes



Small (250 ml)

Medium (500 ml)

Big (1000 ml)

Sizes



Transparent

Red

Green

Orange

Colours

Plate 1: Different types of traps evaluated



Plate 2: Big transparent cylinder (CT3) with fruit flies

Collection of fruit flies trapped in each trap was made four times in a week, treating two alternate days collection as one replication (Gopaul and Price, 1999) and thus there were two replications in the experimentation. All the fruit flies attracted to the traps were identified by using the keys (Ramani, 1997), counted and mean fruit flies trapped per day/trap in each standard week was recorded species wise.

Fruit fly collection of each species during fruiting (July to November) and non-fruiting (December to March) period of guava and mango (January to March and July to December, respectively) as well as for the entire period was pooled separately and the data were analysed by 3-factorial analysis, after $\sqrt{(x+0.5)}$ transformation.

3.1.2 Experiment-2: Evaluation of different coloured methyl eugenol traps in attracting fruit flies in guava orchard at Hosaritti

This experiment was conducted to study the influence of colour in attracting fruit flies which was carried out in a farmer's guava orchard (5 acres) at Hosaritti (Dt. Haveri) from 4th week of August to 3rd week of November, 2003 (Plate 3).

Methyl eugenol traps prepared using 1000 ml bottles were set up in guava orchard in a randomized block design with four treatments replicated five times. The treatments were as follows

T₁: Green bottle trap

T₂: Red bottle trap

T₃: Orange bottle trap

T₄: Transparent bottle trap



Plate 3: A view of guava orchard (Hosaritti)



Plate 4: Charging of traps with methyl eugenol

Charging and servicing of traps was similar to the method followed at UAS, Dharwad (Plate 4). Collections of fruit flies from each trap was made at weekly intervals and later such weekly collections were pooled month-wise. All the collection was identified and counted and the data were subjected to analysis, after $\sqrt{(x+0.5)}$ transformation.

3.1.3 Experiment-3: Evaluation of commercial traps in attracting fruit flies in mixed orchard at Navalur

In this experiment, two commercial melon fruit fly traps namely Fligh-T™ and Del-Ta trap supplied by Pest Control (India), Bangalore were evaluated in comparison with modified steiner trap in a mixed orchard of guava, mango and cucumber at Navalur for their efficacy in attracting fruit flies, from 10th April to 28th May, 2004 (Plate 5). There were three treatments replicated twice and the details of treatments are as follows.

T₁: Fligh-T™ trap charged with cuelure + dichlorvos (at fortnightly intervals)

T₂: Del-Ta trap smeared with grease

T₃: Modified steiner trap charged with cuelure + dichlorvos (at fortnightly intervals)

Collection of fruit flies trapped was made twice a week throughout the study period. They were identified and counted and the data were subjected to the test of significance (t) to compare the trapping efficiency.

3.2 SPECIES COMPLEX AND RELATIVE ABUNDANCE OF DIFFERENT SPECIES OF FRUIT FLIES IN GUAVA AND MANGO

Total fruit flies collected in experiments 1, 2 and 3 (conducted at Dharwad, Hosaritti and Navalur under objective 1) were counted separately for each fruit crop and location, and identified to the species level. The relative abundance of each species was calculated based on the following formula.



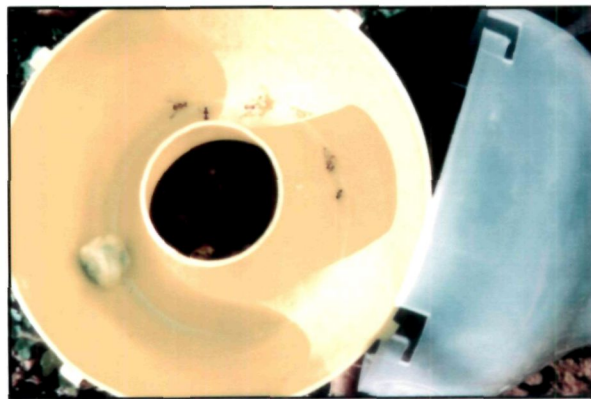
Del-Ta and Fligh-T™ traps



Del-Ta trap



Fligh-T™ trap



Fruit flies trapped in Fligh-T™ trap

Plate 5: Commercial traps evaluated

$$\text{Relative abundance of 'x' species} = \frac{\text{No. of 'x' species of fruit flies trapped}}{\text{Total number of fruit flies trapped}} \times 100$$

3.3 MONITORING OF DIFFERENT SPECIES OF FRUIT FLIES IN GUAVA AND MANGO

Data collected under experiment 1 and 2 of the objective 1, were used for this study. Mean fruit fly collection per trap per week in guava and mango orchards at Dharwad was calculated for each standard week from July 2003 to April 2004 for each species separately.

Similarly mean fruit fly collection per trap per week in guava orchard at Hosaritti was also calculated for each species separately.

3.4 EVALUATION OF PROTEIN FOOD BAITS IN ATTRACTING FEMALE FRUIT FLIES IN GUAVA AND MANGO

This experiment was conducted during peak fruiting season of guava (I week of October to IV week of November) and mango (six weeks during March-April) in a commercial orchard at Navalur (6 acres). Standard modified steiner traps were used for the study.

Different proteins tested were as follows.

Protein food baits were prepared by using papaya and banana as base along with sugar. The experiment was laid out in a randomized block design with 28 treatments and two replications in guava. In mango, there were 16 treatments with two replications. The details of treatments in guava are as follows.

T ₁	Peptone + Sugar + Banana at the ratio of	1:1:1
T ₂	Protone + Sugar + Banana at the ratio of	1:1:1
T ₃	Soybean + Sugar + Banana at the ratio of	1:1:1

T ₄	Yeast + Sugar + Banana at the ratio of	1:1:1
T ₅	Malt + Sugar + Banana at the ratio of	1:1:1
T ₆	Casein + Sugar + Banana at the ratio of	1:1:1
T ₇	Fruit fly diet + Sugar + Banana at the ratio of	1:1:1
T ₈	Peptone + Sugar + Banana at the ratio of	0.5:1:1
T ₉	Protone + Sugar + Banana at the ratio of	0.5:1:1
T ₁₀	Soybean + Sugar + Banana at the ratio of	0.5:1:1
T ₁₁	Yeast + Sugar + Banana at the ratio of	0.5:1:1
T ₁₂	Malt + Sugar + Banana at the ratio of	0.5:1:1
T ₁₃	Casein + Sugar + Banana at the ratio of	0.5:1:1
T ₁₄	Fruit fly diet + Sugar + Banana at the ratio of	0.5:1:1
T ₁₅	Peptone + Sugar + Papaya at the ratio of	1:1:1
T ₁₆	Protone + Sugar + Papaya at the ratio of	1:1:1
T ₁₇	Soybean + Sugar + Papaya at the ratio of	1:1:1
T ₁₈	Yeast + Sugar + Papaya at the ratio of	1:1:1
T ₁₉	Malt + Sugar + Papaya at the ratio of	1:1:1
T ₂₀	Casein + Sugar + Papaya at the ratio of	1:1:1
T ₂₁	Fruit fly diet + Sugar + Papaya at the ratio of	1:1:1
T ₂₂	Peptone + Sugar + Papaya at the ratio of	0.5:1:1
T ₂₃	Protone + Sugar + Papaya at the ratio of	0.5:1:1
T ₂₄	Soybean + Sugar + Papaya at the ratio of	0.5:1:1
T ₂₅	Yeast + Sugar + Papaya at the ratio of	0.5:1:1
T ₂₆	Malt + Sugar + Papaya at the ratio of	0.5:1:1
T ₂₇	Casein + Sugar + Papaya at the ratio of	0.5:1:1
T ₂₈	Fruit fly diet + Sugar + Papaya at the ratio of	0.5:1:1

The details of treatments in mango are as follows

T ₁	Yeast + Sugar + Banana at the ratio of	1:1:1
T ₂	Malt + Sugar + Banana at the ratio of	1:1:1
T ₃	Soybean + Sugar + Banana at the ratio of	1:1:1
T ₄	Peptone + Sugar + Banana at the ratio of	1:1:1
T ₅	Fruit fly diet + Sugar + Banana at the ratio of	1:1:1
T ₆	Casein + Sugar + Banana at the ratio of	1:1:1
T ₇	Protone + Sugar + Banana at the ratio of	1:1:1
T ₈	Yeast + Sugar + Papaya at the ratio of	1:1:1
T ₉	Malt + Sugar + Papaya at the ratio of	1:1:1
T ₁₀	Soybean + Sugar + Papaya at the ratio of	1:1:1
T ₁₁	Peptone + Sugar + Papaya at the ratio of	1:1:1
T ₁₂	Fruit fly diet + Sugar + Papaya at the ratio of	1:1:1
T ₁₃	Casein + Sugar + Papaya at the ratio of	1:1:1
T ₁₄	Protone + Sugar + Papaya at the ratio of	1:1:1
T ₁₅	Papaya + Sugar at the ratio of	1:1
T ₁₆	Banana + Sugar at the ratio of	1:1

The food baits were placed in small plastic cups and kept inside the traps and a distance of 30 m was maintained between the two traps. The bait was always kept in a semi liquid state by adding water at regular intervals. Weekly observations on the number of fruit flies trapped in each trap were recorded, sexed and counted. Efficiency of each combination of food lure was evaluated by simple RBD analysis, after $\sqrt{(x+0.5)}$ transformation of the data.

3.5 RELATIONSHIP BETWEEN TRAP CATCHES AND WEATHER PARAMETERS

The influence of weather factors on trap catches (data collected under experiment I of objective 1) was studied in guava and mango orchards at Dharwad.

Meteorological parameters like maximum temperature, minimum temperature, morning and afternoon relative humidity and rainfall data were collected from Meteorological observatory, Main Agricultural Research Station, Dharwad and means were calculated according to standard week.

Correlations were made between trap catches and mean weather parameters like maximum temperature, minimum temperature, morning and afternoon relative humidity and rainfall for every standard week.

Experimental Results

IV. EXPERIMENTAL RESULTS

Results of various experiments conducted to evaluate the efficacy of different types of traps, to study species complex and their relative abundance, monitoring, evaluation of female targeted protein food baits and relationship between trap catches and weather parameters are presented in this chapter.

4.1 EVALUATION OF DIFFERENT TYPES OF TRAPS IN ATTRACTING FRUIT FLIES IN GUAVA AND MANGO

4.1.1 Experiment- 1: Evaluation of different types of traps in attracting fruit flies in guava and mango orchards at Dharwad

Response of *B. dorsalis* during fruiting period in guava

Significantly greater catches (0.98 fruit flies/trap/day) were recorded in medium transparent bottle (BT2) which was on par with trap catches in ST1, SG1, SO1, BR2, CT2, CG2, SG2, BT3, BG3, BO3, CT3, CR3, CG3, CO3, ST3, SR3 and SO3. Lowest catches were obtained in small transparent bottle (BT1) and medium red sphere (SR2) (0.33 fruit flies/trap /day) (Table 2).

Interaction between shape and size

Mean number of fruit flies captured was significantly high in big traps with 0.70 fruit flies/trap/day with shape having no effect on fruit fly capture. Shape and size of the trap together had no significant influence on the trap catch (Table 2.1).

Interaction between colour and size

Mean fruit fly trap catches in different coloured traps ranged from 0.54 to 0.65 fruit flies/trap/day which however did not vary statistically (Table 2.1). There was no combined effect of colour and size of the trap on trap catches.

Table 2. Response of *B. dorsalis* to different types of traps in guava during different periods at Dharwad

Treatments	Mean trap catch/day/trap during		
	Fruiting	Non-fruiting	Pooled
BT1	0.33 ^e	0.14 ^{ab}	0.24 ^{fgh}
BR1	0.38 ^{de}	0.06 ^{ab}	0.22 ^{gh}
BG1	0.48 ^{bcde}	0.11 ^{ab}	0.29 ^{bcdefgh}
BO1	0.48 ^{bcde}	0.12 ^{ab}	0.30 ^{abcdefgh}
CT1	0.43 ^{bcde}	0.14 ^{ab}	0.28 ^{cdefgh}
CR1	0.48 ^{bcde}	0.11 ^{ab}	0.29 ^{cdefgh}
CG1	0.45 ^{bcde}	0.07 ^{ab}	0.26 ^{efgh}
CO1	0.60 ^{bcde}	0.10 ^{ab}	0.35 ^{abcdefg}
ST1	0.70 ^{abcde}	0.19 ^a	0.45 ^{abcd}
SR1	0.50 ^{bcde}	0.12 ^{ab}	0.32 ^{abcdefgh}
SG1	0.70 ^{abcde}	0.06 ^{ab}	0.39 ^{abcdefgh}
SO1	0.65 ^{abcde}	0.02 ^b	0.34 ^{abcdefgh}
BT2	0.98 ^a	0.03 ^b	0.51 ^a
BR2	0.85 ^{ab}	0.03 ^b	0.45 ^{abcde}
BG2	0.60 ^{bcde}	0.14 ^{ab}	0.37 ^{abcdefg}
BO2	0.48 ^{bcde}	0.20 ^a	0.34 ^{abcdefgh}
CT2	0.65 ^{abcde}	0.08 ^{ab}	0.37 ^{abcdefg}
CR2	0.48 ^{bcde}	0.04 ^b	0.26 ^{defgh}
CG2	0.63 ^{abcde}	0.12 ^{ab}	0.37 ^{abcdefg}
CO2	0.40 ^{cde}	0.06 ^{ab}	0.23 ^{fgh}
ST2	0.60 ^{bcde}	0.11 ^{ab}	0.36 ^{abcdefgh}
SR2	0.33 ^e	0.05 ^{ab}	0.19 ^h
SG2	0.78 ^{abcd}	0.03 ^b	0.41 ^{abcdef}
SO2	0.58 ^{bcde}	0.03 ^b	0.38 ^{abcdefg}
BT3	0.70 ^{abcde}	0.08 ^{ab}	0.39 ^{abcdef}
BR3	0.40 ^{cde}	0.12 ^{ab}	0.26 ^{defgh}
BG3	0.80 ^{abcd}	0.04 ^b	0.42 ^{abcde}
BO3	0.78 ^{abcd}	0.17 ^{ab}	0.47 ^{abc}
CT3	0.68 ^{abcde}	0.03 ^b	0.34 ^{abcdefgh}
CR3	0.65 ^{abcde}	0.04 ^b	0.35 ^{abcdefg}
CG3	0.83 ^{abc}	0.03 ^b	0.42 ^{abcde}
CO3	0.68 ^{abcde}	0.07 ^{ab}	0.37 ^{efgh}
ST3	0.78 ^{abcd}	0.10 ^{ab}	0.44 ^{abcde}
SR3	0.80 ^{abcd}	0.16 ^a	0.49 ^{ab}
SG3	0.58 ^{bcde}	0.05 ^{ab}	0.32 ^{abcdefgh}
SO3	0.80 ^{abcd}	0.09 ^{ab}	0.45 ^{abcde}

Means followed by the same alphabet do not differ significantly by DMRT at 5%

Table 2.1. Interaction between various parameters and trap catches of *B. dorsalis* during fruiting period in guava

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.41	0.49	0.64	0.51 ^b
Medium	0.73	0.54	0.57	0.61 ^b
Big	0.67	0.71	0.74	0.70 ^a
Mean	0.60 ^a	0.58 ^a	0.65 ^a	0.61

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.48	0.45	0.54	0.58	0.51 ^b
Medium	0.74	0.55	0.67	0.48	0.61 ^b
Big	0.72	0.62	0.73	0.75	0.70 ^a
Mean	0.65 ^a	0.54 ^a	0.65 ^a	0.60 ^a	0.61

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.67	0.54	0.63	0.58	0.60 ^a
Cylinder	0.58	0.53	0.63	0.56	0.58 ^a
Sphere	0.69	0.54	0.68	0.68	0.65 ^a
Mean	0.65 ^a	0.54 ^a	0.65 ^a	0.60 ^a	0.61

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Interaction between colour and shape

Mean trap catches in bottles, cylinders and spheres irrespective of colour was similar (0.60, 0.58 and 0.65 fruit flies/trap/day, respectively) (Table 2.1), Colour and shape together did not influence the trap catch.

Response of *B. dorsalis* during non-fruiting period in guava

The trap catches of *B. dorsalis* during non-fruiting period was quite low. It was statistically at the same level of 0.06 to 0.20 fruit flies/trap/day in all the traps except in SO1, BT2, BR2, CT3, CG3, CR2, SO2, SG2, BG3 and CR3 where the trap catches were significantly low (0.03 to 0.04 fruit flies /trap/day) (Table 2).

Interaction between shape and size

Mean trap catches in small, medium and big traps were 0.1, 0.07 and 0.08 fruit flies/trap/day, respectively. Similarly trap catches in bottle, cylinder and sphere were 0.1, 0.07 and 0.08 fruit flies/trap/day, respectively. However, these trap catches did not vary statistically (Table 2.2). Similarly shape and size together had no influence on the trap catch.

Interaction between colour and size

Transparent, red, green and orange traps irrespective of their size attracted mean fruit flies of 0.09, 0.08, 0.07 and 0.09 fruit flies/trap/day which however did not differ from each other (Table 2.2). Similarly colour and size of the trap together had no influence on the trap catch.

Interaction between colour and shape

Mean trap catches of *B. dorsalis* in different coloured traps when compared against different shapes varied from 0.04 to 0.16 fruit flies/trap/day which however did not differ statistically (Table 2.2).

Table 2.2. Interaction between various parameters and trap catches of *B. dorsalis* during non-fruiting period in guava

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.10	0.10	0.10	0.10 ^a
Medium	0.10	0.07	0.05	0.07 ^a
Big	0.10	0.03	0.10	0.08 ^a
Mean	0.10 ^a	0.07 ^a	0.08 ^a	0.08

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.15	0.10	0.08	0.08	0.10 ^a
Medium	0.07	0.04	0.09	0.09	0.07 ^a
Big	0.06	0.11	0.03	0.11	0.08 ^a
Mean	0.09 ^a	0.08 ^a	0.07 ^a	0.09 ^a	0.083

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.08	0.07	0.09	0.16	0.10 ^a
Cylinder	0.07	0.06	0.06	0.07	0.07 ^a
Sphere	0.13	0.11	0.05	0.04	0.08 ^a
Mean	0.09 ^a	0.08 ^a	0.07 ^a	0.09 ^a	0.08

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Response of *B. dorsalis* during fruiting and non-fruiting periods in guava (Pooled)

Trap attraction of medium transparent bottle (BT2) was significantly more (0.51 fruit flies/trap/day) which was however on par with trap catches in BO1, CO1, ST1, SR1, SG1, SO1, BR2, BG2, BO2, CT2, CG2, ST2, SG2, SO2, BT3, BG3, BO3, CT3, CR3, CG3, ST3, SR3, SG3 and SO3. Medium red sphere (SR2) was found to be inferior with least trap catch of 0.19 fruit flies/trap/day (Table 2).

Interaction between shape and size

All shapes were equally attractive to *B. dorsalis* with mean catches of 0.32 to 0.37 fruit flies/trap/day. But among different sizes, response was more towards larger size (medium and big) of the traps with 0.35 and 0.39 fruit flies/trap/day in medium and big traps which however did not differ significantly. Both shape and size of the trap together had significant influence on trap catch with highest catches in big sphere (0.42 fruit flies) and lowest (0.26 fruit flies) in small bottle (Table 2.3).

Interaction between colour and size

B. dorsalis failed to respond to different colour of the traps as the mean trap catches which ranged from 0.31 to 0.37 did not vary significantly when compared against the size of the traps. Similarly colour and size together had no influence on the trap catch (Table 2.3).

Interaction between colour and shape

Mean trap catches in different coloured traps though varied from 0.30 to 0.41 fruit flies/trap/day did not differ statistically when compared against shapes of the traps (Table 2.3).

Table 2.3. Interaction between various parameters and trap catches of *B. dorsalis* during fruiting and non-fruiting periods in guava (Pooled)

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.26	0.30	0.37	0.31 ^b
Medium	0.41	0.31	0.33	0.35 ^a
Big	0.39	0.37	0.42	0.39 ^a
Mean	0.35 ^a	0.32 ^a	0.37 ^a	0.35

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.32	0.28	0.31	0.33	0.31 ^b
Medium	0.41	0.30	0.38	0.32	0.35 ^a
Big	0.39	0.37	0.38	0.43	0.39 ^a
Mean	0.37 ^a	0.31 ^a	0.36 ^a	0.36 ^a	0.35

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.38	0.31	0.36	0.37	0.35 ^a
Cylinder	0.33	0.30	0.35	0.32	0.32 ^a
Sphere	0.41	0.33	0.37	0.39	0.37 ^a
Mean	0.37 ^a	0.31 ^a	0.36 ^a	0.36 ^a	0.35

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Response of *B. correcta* during fruiting period in guava

Fruit flies responded significantly more to big (20 cm diameter) red sphere (SR3) with highest catches of 15.53 fruit flies/trap/day. Green medium cylinder (CG2) attracted the next higher number of fruit flies (13.6 fruit flies/trap/day). Red bottle (1000 ml) (BR3) and orange bottle (500 ml) (BO2) were least effective with 4.28 and 4.33 fruit flies/trap/day, respectively (Table 3).

Interaction between shape and size

Attraction of medium and bigger traps was significantly more and equal with mean catch of 7.30 and 7.61 fruit flies/trap/day, respectively. Spherical traps gave the best result among various shapes attracting more fruit flies (8.2 fruit flies/trap/day). Shape and size together had significant influence on trap catches with lowest (5.65 fruit flies) and highest (9.29 fruit flies) in small cylinder and big sphere, respectively (Table 3.1).

Interaction between colour and size

Maximum mean trap catch was recorded in green coloured trap (7.54 fruit flies/trap/day) followed by transparent (7.09 fruit flies/trap/day) which was at par with red (7.09 fruit flies/trap/day) and orange (6.89 fruit flies/trap/day) coloured traps. Colour and size together had significant influence on the trap catch which ranged from 5.71 to 9.34 fruit flies in medium and big red trap, respectively (Table 3.1).

Interaction between colour and shape

Colour and shape together influenced the trap catches significantly with lowest catches of 4.99 fruit flies in green cylinder and highest of 9.49 fruit flies in red sphere (Table 3.1).

Table 3. Response of *B. correcta* to different types of traps in guava during different periods at Dharwad

Treatments	Mean trap catch/day/trap during		
	Fruiting	Non-fruiting	Pooled
BT1	8.16 ^{fg}	5.72 ^b	6.95 ^{cd}
BR1	5.10 ^{pq}	4.40 ^c	4.40 ⁿ
BG1	4.66 st	4.75 ^c	4.71 ^{lmn}
BO1	7.23 ^{ij}	5.47 ^b	6.35 ^{def}
CT1	4.45 ^{tu}	4.30 ^c	4.38 ⁿ
CR1	6.26 ^{lm}	4.03 ^c	5.15 ^{ijklmn}
CG1	6.65 ^k	4.05 ^c	5.34 ^{hijklm}
CO1	5.23 ^{op}	5.17 ^b	5.20 ^{ijklm}
ST1	4.90 ^{qr}	5.27 ^b	5.09 ^{ijklmn}
SR1	7.05 ^j	5.71 ^b	6.38 ^{de}
SG1	8.23 ^f	4.33 ^c	6.28 ^{defg}
SO1	10.73 ^c	4.69 ^c	7.71 ^c
BT2	10.74 ^c	6.83 ^a	8.79 ^b
BR2	6.22 ^{lm}	5.27 ^b	5.75 ^{efghij}
BG2	6.39 ^l	4.93 ^b	5.66 ^{efghijk}
BO2	4.33 ^u	5.03 ^b	4.68 ^{lmn}
CT2	6.10 ^m	4.76 ^c	5.44 ^{fghijkl}
CR2	5.13 ^{pq}	4.06 ^c	4.59 ^{mn}
CG2	13.60 ^b	5.91 ^b	9.76 ^a
CO2	4.83 ^{rs}	6.26 ^a	5.55 ^{efghijk}
ST2	7.40 ⁱ	4.14 ^c	5.77 ^{efghij}
SR2	5.75 ⁿ	5.55 ^b	5.65 ^{efghij}
SG2	8.03 ^{fg}	4.48 ^c	6.26 ^{defg}
SO2	9.15 ^d	4.75 ^c	6.96 ^{cd}
BT3	7.31 ⁱ	6.74 ^a	7.03 ^{cd}
BR3	4.28 ^u	6.60 ^a	5.44 ^{ghijkl}
BG3	6.75 ^k	5.71 ^b	6.23 ^{defgh}
BO3	7.98 ^g	6.06 ^a	7.02 ^{cd}
CT3	6.15 ^{lm}	4.47 ^c	5.31 ^{ijklm}
CR3	8.48 ^e	3.70 ^d	6.09 ^{defghi}
CG3	8.23 ^f	4.70 ^c	6.47 ^{de}
CO3	4.93 ^{qr}	4.67 ^c	4.79 ^{klmn}
ST3	8.63 ^e	6.98 ^a	7.81 ^c
SR3	15.53 ^a	4.72 ^c	10.13 ^a
SG3	5.38 ^o	4.03 ^c	4.71 ^{lmn}
SO3	7.65 ^h	6.39 ^a	7.02 ^{cd}

Means followed by the same alphabet do not differ significantly by DMRT at 5%

Table 3.1. Interaction between various parameters and trap catches of *B. correcta* during fruiting period in guava

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	6.29	5.65	7.73	6.55 ^b
Medium	6.92	7.41	7.58	7.30 ^a
Big	6.58	6.94	9.29	7.61 ^a
Mean	6.59 ^b	6.67 ^b	8.20 ^a	7.15

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	5.84	6.14	6.51	7.73	6.55 ^b
Medium	8.08	5.70	9.34	6.10	7.30 ^a
Big	7.36	9.43	6.78	6.85	7.61 ^a
Mean	7.09 ^b	7.09 ^b	7.54 ^a	6.89 ^b	7.15

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	8.74	5.20	5.93	6.51	6.59 ^b
Cylinder	5.57	6.62	9.49	4.99	6.67 ^b
Sphere	6.98	9.44	7.21	9.18	8.20 ^a
Mean	7.09 ^b	7.09 ^b	7.54 ^a	6.89 ^b	7.15

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Response of *B. correcta* during non-fruiting period in guava

Significantly higher number of *B. correcta* were attracted to medium transparent bottle (BT2), medium orange cylinder (CO2), big transparent (BT3), red (BR3) and orange bottle (BO3) and big transparent and orange sphere traps (ST3 and SO3) (6.06 to 6.98 fruit flies/trap/day). However red big cylinder attracted lowest number of fruit flies (3.7 fruit flies/trap/day) (Table 3).

Interaction between shape and size

The mean number of *B. correcta* was highest in bottle trap (5.62 fruit flies) followed by spheres and cylinders. Trap catches significantly increased with increase in size with big trap attracting highest number of *B. correcta* (5.39 fruit flies/trap/day). Size and shape together influenced the trap catch with lowest catches (4.38 fruit flies) in big cylinder and highest (6.27 fruit flies) in big bottle trap (Table 3.2).

Interaction between colour and size

Significantly higher capture of *B. correcta* was obtained in transparent and orange coloured traps with 5.47 and 5.39 fruit flies/trap/day, respectively, when compared with the size. But colour and size together had no influence on trap catch (Table 3.2).

Interaction between colour and shape

The mean trap catches in different coloured traps when compared against shape, varied significantly and the catches ranged from 3.93 to 6.43 fruit flies/trap/day in red cylinder and transparent bottle, respectively (Table 3.2).

Response of *B. correcta* during fruiting and non-fruiting periods in guava (pooled)

Fruit flies showed a significant preference for big red sphere (SR3) and medium green cylinder (CG2) over others with a trap catch of 10.13 and 9.76 fruit flies/trap/day,

Table 3.2. Interaction between various parameters and trap catches of *B. correcta* during non-fruiting period in guava

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	5.08	4.39	5.00	4.82 ^c
Medium	5.51	5.25	4.73	5.16 ^b
Big	6.27	4.38	5.53	5.39 ^a
Mean	5.62 ^a	4.67 ^c	5.08 ^b	5.13

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	5.09	4.71	4.38	5.11	4.82 ^c
Medium	5.24	4.96	5.11	5.35	5.16 ^b
Big	6.06	5.00	4.81	5.70	5.39 ^a
Mean	5.47 ^a	4.89 ^b	4.76 ^b	5.39 ^a	5.13

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	6.43	5.42	5.13	5.52	5.62 ^a
Cylinder	4.51	3.93	4.88	5.37	4.67 ^c
Sphere	5.46	5.32	4.28	5.27	5.08 ^b
Mean	5.47 ^a	4.89 ^b	4.76 ^b	5.39 ^a	5.13

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

respectively. Medium transparent bottle trap (BT2) attracted next highest fruit flies (8.79 fruit flies/trap/day). However significantly lower catches were recorded in small red bottle (BR1) and transparent cylinder (CT1) (Table 3).

Interaction between shape and size

Mean trap catches significantly increased with increase in size with highest trap catches of 6.50 fruit flies/trap/day in bigger traps. Among the different shapes, the spheres attracted highest fruit flies (6.65) followed by bottle and cylinder (Table 3.3). Both parameters had a significant influence on trap catches with small cylinder and big sphere attracting lowest (5.01 fruit flies) and highest (7.41 fruit flies) catches, respectively.

Interaction between colour and size

Mean trap catches which varied from 5.95 to 6.28 fruit flies/trap/day in different coloured traps did not vary significantly. However, interaction of trap catches between colour and size was significant with lowest catch (5.31 fruit flies) in small red trap and highest catch (7.23 fruit flies) in medium green trap (Table 3.3).

Interaction between colour and shape

The interaction of mean catches in different coloured traps compared with different shapes of traps revealed significant differences with red sphere attracting more fruit flies (7.39 fruit flies/trap/day) followed by orange sphere (7.23 fruit flies/trap/day). Among the bottle traps, transparent bottle attracted more fruit flies (7.59 fruit flies/trap/day) (Table 3.3).

Response of *B. zonata* during fruiting period in guava

Small orange cylinder (CO1) attracted significantly more *B. zonata* with 0.78 fruit flies/trap/day, which was however on par with BT1, CT1, CG1, SR1, SG1, SO1, BT2,

Table 3.3. Interaction between various parameters and trap catches of *B. correcta* during fruiting and non-fruiting periods in guava (Pooled)

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	5.60	5.01	6.36	5.66 ^c
Medium	6.22	6.33	6.16	6.24 ^b
Big	6.43	5.67	7.41	6.50 ^a
Mean	6.08 ^b	5.67 ^c	6.65 ^a	6.13

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	5.47	5.31	5.44	6.42	5.66 ^c
Medium	6.66	5.33	7.23	5.73	6.24 ^b
Big	6.71	7.22	5.80	6.28	6.50 ^a
Mean	6.28 ^a	5.95 ^a	6.16 ^a	6.14 ^a	6.13

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	7.59	5.20	5.53	6.01	6.08 ^b
Cylinder	5.04	5.28	7.19	5.18	5.67 ^c
Sphere	6.22	7.39	5.75	7.23	6.65 ^a
Mean	6.28 ^a	5.95 ^a	6.16 ^a	6.14 ^a	6.13

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

BG2, CT2, CO2, SR2, BT3, BO3, CT3, CR3, CG3, CO3, SR3, SG3 and SO3. All the remaining traps attracted 0.20 to 0.38 fruit flies/trap/day, and were at par with each other (Table 4).

Interaction between shape and size

Mean fruit fly catches in small, medium and big traps were 0.40, 0.37 and 0.48 fruit flies/trap/day, respectively, which however did not vary statistically. Similarly mean catches in bottle, cylinder and sphere traps were 0.35, 0.47 and 0.42 fruit flies, respectively. Thus *B. zonata* did not distinguish between traps of different shape and size (Table 4.1).

Interaction between colour and size

Orange coloured traps irrespective of size attracted more *B. zonata* (0.47 fruit flies/trap/day), but other coloured traps were equally effective statistically with 0.36 to 0.43 fruit flies/trap/day. Colour and size together had no influence on the trap catch (Table 4.1).

Interaction between colour and shape

Mean trap catches when compared between different coloured traps against different shapes, though varied from 0.26 in red coloured bottle to 0.62 in orange coloured cylinder, were at par statistically (Table 4.1).

Response of *B. zonata* during non-fruiting period in guava

Significantly maximum trap catch was obtained in big transparent bottle (BT3) (1.44 fruit flies/trap/day) which was on par with trap catches in red medium bottle (BR2) (1.41) and big orange bottle (BO2) (0.90 fruit flies/trap/day). Significantly lower catch was observed in SR3 (0.1 fruit flies/trap/day) and SG2 (0.08 fruit flies/trap/day) (Table 4).

Table 4. Response of *B. zonata* to different types of traps in guava during different periods at Dharwad

Treatments	Mean trap catch/day/trap during		
	Fruiting	Non-fruiting	Pooled
BT1	0.42 ^{ab}	0.35 ^c	0.39 ^{bcdefg}
BR1	0.20 ^b	0.26 ^c	0.33 ^{cdefg}
BG1	0.27 ^b	0.34 ^c	0.40 ^{bcdefg}
BO1	0.25 ^b	0.20 ^c	0.23 ^{efg}
CT1	0.40 ^a	0.30 ^c	0.26 ^{defg}
CR1	0.20 ^b	0.52 ^b	0.37 ^{bcdefg}
CG1	0.40 ^{ab}	0.19 ^c	0.40 ^{bcdefg}
CO1	0.78 ^a	0.53 ^b	0.65 ^{ab}
ST1	0.32 ^b	0.19 ^c	0.26 ^{defg}
SR1	0.45 ^{ab}	0.48 ^b	0.47 ^{bcdef}
SG1	0.65 ^a	0.35 ^c	0.50 ^{bcdef}
SO1	0.47 ^{ab}	0.35 ^c	0.41 ^{bcdefg}
BT2	0.45 ^{ab}	0.83 ^b	0.64 ^{abc}
BR2	0.34 ^b	1.41 ^a	0.88 ^a
BG2	0.45 ^{ab}	0.32 ^c	0.39 ^{bcdefg}
BO2	0.28 ^b	0.28 ^c	0.28 ^{defg}
CT2	0.58 ^{ab}	0.22 ^c	0.40 ^{bcdefg}
CR2	0.23 ^b	0.24 ^c	0.24 ^{defg}
CG2	0.30 ^b	0.24 ^c	0.27 ^{defg}
CO2	0.40 ^a	0.26 ^c	0.31 ^{defg}
ST2	0.20 ^b	0.29 ^c	0.25 ^{defg}
SR2	0.43 ^a	0.52 ^b	0.47 ^{bcdef}
SG2	0.38 ^b	0.08 ^d	0.23 ^{fg}
SO2	0.38 ^b	0.36 ^c	0.37 ^{bcdefg}
BT3	0.53 ^a	1.44 ^a	0.99 ^a
BR3	0.24 ^b	0.21 ^c	0.19 ^g
BG3	0.34 ^b	0.50 ^b	0.42 ^{bcdefg}
BO3	0.45 ^a	0.90 ^a	0.68 ^{ab}
CT3	0.50 ^a	0.32 ^c	0.42 ^{bcdefg}
CR3	0.65 ^a	0.34 ^c	0.50 ^{bcd}
CG3	0.58 ^a	0.46 ^b	0.52 ^{bcd}
CO3	0.68 ^a	0.30 ^c	0.49 ^{bcde}
ST3	0.32 ^b	0.29 ^c	0.30 ^{defg}
SR3	0.50 ^a	0.10 ^d	0.30 ^{defg}
SG3	0.48 ^a	0.25 ^c	0.37 ^{bcdefg}
SO3	0.53 ^a	0.22 ^c	0.37 ^{bcdefg}

Means followed by the same alphabet do not differ significantly by DMRT at 5%

Table 4.1. Interaction between various parameters and trap catches of *B. zonata* during fruiting period in guava

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.28	0.44	0.47	0.40 ^a
Medium	0.38	0.38	0.34	0.37 ^a
Big	0.39	0.60	0.45	0.48 ^a
Mean	0.35 ^a	0.47 ^a	0.42 ^a	0.42

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.38	0.28	0.44	0.50	0.40 ^a
Medium	0.41	0.33	0.38	0.35	0.37 ^a
Big	0.45	0.46	0.46	0.55	0.48 ^a
Mean	0.41 ^a	0.36 ^a	0.43 ^a	0.47 ^a	0.42

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.46	0.26	0.35	0.33	0.35 ^a
Cylinder	0.49	0.36	0.43	0.62	0.47 ^a
Sphere	0.28	0.46	0.50	0.46	0.42 ^a
Mean	0.41 ^a	0.36 ^a	0.43 ^a	0.47 ^a	0.42

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Interaction between shape and size

Among various shapes tested, bottle traps were better attracting significantly more fruit flies (0.58 fruit flies/trap/day) followed by cylinders (0.32 fruit flies/trap/day), which was at par with the spheres (0.29 fruit flies/trap/day). However, the mean trap catches did not vary in different sizes of the traps, but shape and size together had significant influence on trap catch with lowest (0.21 fruit flies) and highest (0.76 fruit flies) in big sphere and bottle, respectively (Table 4.2).

Interaction between colour and size

Transparent (0.47 fruit flies/trap/day), red (0.45 fruit flies/trap/day) and orange (0.38 fruit flies/trap/day) traps were equally and more attractive regardless of size of the trap. Green coloured traps were least preferred by *B. zonata* with 0.3 fruit flies/trap/day. However, colour and size of the trap had significant influence on trap catches with medium green and red traps attracting lowest (0.21 fruit flies) and highest (0.72 fruit flies) captures, respectively (Table 4.2).

Interaction between colour and shape

Colour and shape of the trap together influenced the trap catches significantly with lowest catch of 0.26 fruit flies in transparent sphere and highest catch of 0.87 fruit flies in transparent bottle (Table 4.2).

Response of *B. zonata* during fruiting and non-fruiting periods in guava (pooled)

Higher trap catch was recorded in big transparent bottle (BT3) and medium red bottle (BR2) with 0.99 and 0.88 fruit flies/trap/day, respectively. Big orange bottle trap (BO3) (0.68 fruit flies/trap/day), small orange cylindrical trap (CO1) (0.65 fruit

Table 4.2. Interaction between various parameters and trap catches of *B. zonata* during non-fruiting period in guava

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.28	0.38	0.34	0.34 ^a
Medium	0.71	0.24	0.31	0.42 ^a
Big	0.76	0.35	0.21	0.44 ^a
Mean	0.58 ^a	0.32 ^b	0.29 ^b	0.40

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.28	0.42	0.29	0.36	0.34 ^a
Medium	0.45	0.72	0.21	0.30	0.42 ^a
Big	0.68	0.22	0.40	0.47	0.44 ^a
Mean	0.47 ^a	0.45 ^a	0.30 ^b	0.38 ^a	0.40

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.87	0.62	0.38	0.46	0.58 ^a
Cylinder	0.28	0.36	0.29	0.36	0.32 ^b
Sphere	0.26	0.37	0.22	0.31	0.29 ^b
Mean	0.47 ^a	0.45 ^a	0.30 ^b	0.38 ^a	0.40

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

flies/trap/day) and medium transparent bottle (BT2) (0.64 fruit flies/trap/day) also captured equivalent number of fruit flies (Table 4).

Interaction between shape and size

Significantly higher number of fruit flies were trapped in bottle traps with a trap catch of 0.48 fruit flies/trap/day which was on par with catches in cylinder traps. However, mean trap catches did not vary in different sizes of traps. But shape and size of the trap together had significant influence on trap catches with lowest catches in medium cylinder (0.30 fruit flies) and highest in big bottle (0.57 fruit flies) (Table 4.3).

Interaction between colour and size

Mean trap catches in different coloured traps though varied from 0.39 in green trap to 0.43 fruit flies in transparent traps was non-significant. However, the interaction between trap catches in different coloured traps against different size of the trap was significantly different. Small transparent trap captured lowest number of fruit flies (0.30) while transparent big trap captured highest number (0.57 fruit flies) (Table 4.3).

Interaction between colour and shape

Either colour or shape had no effect on mean trap catches. However, the interaction of trap catches between colour and shape had significant influence on trap catches with lowest catches of 0.27 in transparent sphere and greater catches of 0.67 in transparent bottle (Table 4.3).

Response of *B. dorsalis* during fruiting period in mango

Among different traps tested, medium orange cylinder (CO2) and big orange sphere trap (SO3) were significantly more attractive with 0.25 and 0.29 fruit flies per trap

Table 4.3. Interaction between various parameters and trap catches of *B. zonata* during fruiting and non-fruiting periods in guava (Pooled)

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.34	0.42	0.41	0.39 ^a
Medium	0.55	0.30	0.33	0.39 ^a
Big	0.57	0.48	0.33	0.46 ^a
Mean	0.48 ^a	0.40 ^{ab}	0.36 ^b	0.41

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.30	0.39	0.43	0.43	0.39 ^a
Medium	0.43	0.53	0.30	0.32	0.39 ^a
Big	0.57	0.33	0.43	0.51	0.46 ^a
Mean	0.43 ^a	0.41 ^a	0.39 ^a	0.42 ^a	0.41

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.67	0.46	0.40	0.39	0.48 ^a
Cylinder	0.36	0.37	0.40	0.48	0.40 ^{ab}
Sphere	0.27	0.41	0.37	0.38	0.36 ^b
Mean	0.43 ^a	0.41 ^a	0.39 ^a	0.42 ^a	0.41

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

per day, respectively. Medium red cylindrical trap (CR2) and green sphere (SG2) attracted next higher number of fruit flies (0.19 fruit flies/trap/day) (Table 5).

Interaction between shape and size

Shape and size together did not influence the attractiveness of traps to fruit flies. But fruit fly capture in medium and big traps was significantly higher (0.13 and 0.09 fruit flies/trap/day) than small size. Spheres were more attractive with 0.13 fruit flies/trap/day but the captures in bottle and cylindrical traps did not differ significantly (Table 5.1).

Interaction between colour and size

Mean captures of fruit flies in different coloured traps though ranged from 0.08 to 0.13 fruit flies/trap/day did not vary statistically. Similarly colour and size of the trap together had no influence on trap catches (Table 5.1).

Interaction between colour and shape

Mean catches in traps with different colour and shape when considered together varied from 0.03 to 0.14 fruit flies/trap/day but the variation was non significant (Table 5.1).

Response of *B. dorsalis* during non-fruiting period in mango

The big green sphere (SG3) was the most attractive with 0.77 fruit flies/trap/day. However trap catches in SR1, SO1, BT2, BG2, BO2, CO2, SG2, SO2, CG3, ST3, SR3 and SO3 were at par. Trap catches in BR1, BG1, CT1, CR1, CO1 and CT2 was significantly lower with 0.19 to 0.32 fruit flies/trap/day (Table 5).

Interaction between shape and size

Both medium and bigger traps had equal response with fruit fly catch of 0.47 fruit flies/trap/day. Among different shapes, spherical trap was found to be the best with 0.56

Table 5. Response of *B. dorsalis* to different types of traps in mango during different periods at Dharwad

Treatments	Mean trap catch/day/trap during		
	Fruiting	Non-fruiting	Pooled
BT1	0.03 ^e	0.30 ^{ghij}	0.15 ^{jk}
BR1	0.03 ^e	0.19 ^j	0.13 ^k
BG1	0.03 ^e	0.23 ^j	0.15 ^{jk}
BO1	0.03 ^e	0.25 ^{ij}	0.14 ^k
CT1	0.03 ^e	0.32 ^j	0.16 ^{ijk}
CR1	0.03 ^e	0.23 ^j	0.15 ^{jk}
CG1	0.03 ^e	0.29 ^{hij}	0.18 ^{fghijk}
CO1	0.13 ^c	0.23 ^j	0.24 ^{cdefghijk}
ST1	0.10 ^d	0.40 ^{defghij}	0.23 ^{defghijk}
SR1	0.03 ^e	0.56 ^{abcdef}	0.28 ^{bcdefghij}
SG1	0.16 ^c	0.44 ^{cdefghij}	0.35 ^{abcde}
SO1	0.16 ^c	0.71 ^{ab}	0.49 ^a
BT2	0.16 ^c	0.52 ^{abcdefgh}	0.33 ^{abcdefg}
BR2	0.03 ^e	0.25 ^{ij}	0.16 ^{ijk}
BG2	0.10 ^d	0.57 ^{abcde}	0.32 ^{bcdefgh}
BO2	0.13 ^c	0.71 ^{ab}	0.39 ^{abcd}
CT2	0.07 ^d	0.19 ^j	0.16 ^{ijk}
CR2	0.19 ^b	0.31 ^{fghij}	0.28 ^{bcdefghij}
CG2	0.16 ^c	0.38 ^{defghij}	0.32 ^{abcdefgh}
CO2	0.25 ^a	0.57 ^{abcde}	0.38 ^{abcd}
ST2	0.10 ^d	0.39 ^{defghij}	0.27 ^{cdefghijk}
SR2	0.07 ^d	0.36 ^{efghij}	0.25 ^{cdefghijk}
SG2	0.19 ^b	0.63 ^{abcd}	0.48 ^a
SO2	0.16 ^c	0.75 ^{ab}	0.47 ^a
BT3	0.10 ^d	0.34 ^{efghij}	0.27 ^{cdefghijk}
BR3	0.03 ^e	0.36 ^{efghij}	0.21 ^{efghijk}
BG3	0.03 ^e	0.34 ^{efghij}	0.17 ^{hijk}
BO3	0.07 ^d	0.50 ^{bcdefghi}	0.32 ^{abcdef}
CT3	0.10 ^d	0.39 ^{defghij}	0.27 ^{cdefghijk}
CR3	0.16 ^c	0.29 ^{hij}	0.18 ^{ghijk}
CG3	0.03 ^e	0.55 ^{abcdefg}	0.28 ^{cdefghijk}
CO3	0.03 ^e	0.32 ^{efghij}	0.16 ^{ijk}
ST3	0.10 ^d	0.67 ^{abc}	0.40 ^{abc}
SR3	0.13 ^c	0.52 ^{abcdefgh}	0.29 ^{bcdefghi}
SG3	0.07 ^d	0.77 ^a	0.45 ^{ab}
SO3	0.29 ^a	0.55 ^{abcdefg}	0.47 ^a

Means followed by the same alphabet do not differ significantly by DMRT at 5%

Table 5.1. Interaction between various parameters and trap catches of *B. dorsalis* during fruiting period in mango

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.02	0.05	0.11	0.06 ^b
Medium	0.10	0.17	0.13	0.13 ^a
Big	0.06	0.06	0.14	0.09 ^a
Mean	0.06 ^b	0.09 ^b	0.13 ^a	0.09

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.03	0.03	0.07	0.10	0.06 ^b
Medium	0.11	0.10	0.15	0.18	0.13 ^a
Big	0.10	0.10	0.03	0.12	0.09 ^a
Mean	0.08 ^a	0.08 ^a	0.08 ^a	0.13 ^a	0.09

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.09	0.03	0.05	0.07	0.06 ^b
Cylinder	0.05	0.13	0.06	0.13	0.09 ^b
Sphere	0.10	0.07	0.14	0.20	0.13 ^a
Mean	0.08 ^a	0.08 ^a	0.08 ^a	0.13 ^a	0.09

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

fruit flies/trap/day. However shape and size of the trap together had no influence on trap catches (Table 5.2).

Interaction between colour and size

Green and orange coloured traps were found to be more and equally effective attracting 0.46 and 0.51 fruit flies/trap/day, respectively. But colour and size of the trap together had no significant influence on trap catches (Table 5.2).

Interaction between colour and shape

Colour and shape of the trap together did not influence the trap catches which varied from 0.27 fruit flies in red bottle to 0.67 fruit flies in orange sphere (Table 5.2).

Response of *B. dorsalis* during fruiting and non-fruiting periods in mango (pooled)

Green medium and big spheres (SG2 and SG3) and all orange spheres (SO1, SO2 and SO3) were found to be superior and equally attractive to fruit flies with 0.45 to 0.49 fruit flies/trap/day. Trap catches in SG1, BT2, BO2, CG2, CO2, BO3, ST3 and SG3 were at par. However trap catches in BR1 and BO1 was inferior (0.13 to 0.14 fruit flies/trap/day) (Table 5).

Interaction between shape and size

Among different sized traps, both medium and bigger traps attracted significantly more number of fruit flies with 0.32 and 0.29 fruit flies/trap/day. Among different shapes, spheres were more efficient with 0.37 fruit flies/trap/day. However, shape and size together had no influence on trap catches (Table 5.3).

Table 5.2. Interaction between various parameters and trap catches of *B. dorsalis* during non-fruiting period in mango

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.24	0.27	0.53	0.35 ^b
Medium	0.51	0.36	0.53	0.47 ^a
Big	0.38	0.39	0.63	0.47 ^a
Mean	0.38 ^b	0.34 ^b	0.56 ^a	0.43

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.34	0.33	0.32	0.40	0.35 ^b
Medium	0.37	0.31	0.52	0.68	0.47 ^a
Big	0.47	0.39	0.55	0.45	0.47 ^a
Mean	0.39 ^b	0.34 ^b	0.46 ^a	0.51 ^a	0.43

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.38	0.27	0.38	0.49	0.38 ^b
Cylinder	0.30	0.28	0.40	0.37	0.34 ^b
Sphere	0.49	0.48	0.61	0.67	0.56 ^a
Mean	0.39 ^b	0.34 ^b	0.46 ^a	0.51 ^a	0.43

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Table 5.3. Interaction between various parameters and trap catches of *B. dorsalis* during fruiting and non-fruiting periods in mango (Pooled)

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.14	0.18	0.34	0.22 ^b
Medium	0.30	0.28	0.36	0.32 ^a
Big	0.24	0.22	0.40	0.29 ^a
Mean	0.23 ^b	0.23 ^b	0.37 ^a	0.27

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.18	0.19	0.23	0.29	0.22 ^b
Medium	0.25	0.23	0.37	0.41	0.32 ^a
Big	0.31	0.23	0.30	0.32	0.29 ^a
Mean	0.25 ^b	0.22 ^b	0.30 ^a	0.34 ^a	0.27

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.25	0.17	0.21	0.28	0.23 ^b
Cylinder	0.19	0.20	0.26	0.26	0.23 ^b
Sphere	0.30	0.27	0.43	0.47	0.37 ^a
Mean	0.25 ^b	0.22 ^b	0.30 ^a	0.34 ^a	0.27

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Interaction between colour and size

Orange and green traps yielded significantly greater captures and were equally attractive to fruit flies with 0.34 and 0.30 fruit flies/trap/ day, respectively.

Transparent and red traps were the next best efficient in attracting fruit flies. Combined effect of colour and size of the trap had no influence on trap catch (Table 5.3).

Interaction between colour and shape

Colour and shape of the trap together had significant influence on trap catches with lowest catches in transparent cylinder (0.19 fruit flies/trap/day) and highest in orange sphere (0.47 fruit flies/trap/day) (Table 5.3).

Response of *B. correcta* during fruiting period in mango

B. correcta preferred big green and orange spherical traps (SG3 and SO3) with 9.5 and 8.75 fruit flies/trap/day. Similarly small transparent cylinder (CT1) was also equally preferred (8.38 fruit flies/trap/day). However capture in big transparent cylindrical trap (CT3) was significantly smaller (4.38 fruit flies/trap/day) (Table 6).

Interaction between shape and size

Fruit flies preferred bigger traps with significantly greater capture of 6.24 fruit flies/trap/day. Equal number of flies were attracted to small (5.51 fruit flies/trap/day) and medium sized traps (5.38 fruit flies/trap/day) (Table 6.1).

Similarly spheres attracted significantly more fruit flies (6.02 fruit flies/trap/day) followed by cylinder and bottles which however did not differ significantly. When trap catches in different shapes and sizes were considered together, the catches varied significantly with small and big spheres attracting lowest (5.06 fruit flies) and highest (7.31 fruit flies) catches, respectively (Table 6.1).

Table 6. Response of *B. correcta* to different types of traps in mango during different periods at Dharwad

Treatments	Mean trap catch/day/trap during		
	Fruiting	Non-fruiting	Pooled
BT1	7.09 ^{cd}	5.61 ^{fghijk}	6.35 ^{efghi}
BR1	4.75 ^{jk}	3.30 ^{lm}	4.03 ^o
BG1	5.88 ^{efghi}	3.03 ⁿ	4.45 ^{no}
BO1	4.63 ^{jk}	6.69 ^{defghi}	5.66 ^{ghijkl}
CT1	8.38 ^{ab}	4.09 ^{klm}	6.23 ^{efghij}
CR1	5.00 ^{hijk}	5.67 ^{fghijk}	5.34 ^{hijklmn}
CG1	5.25 ^{ghijk}	5.19 ^{fghijk}	5.23 ^{ijklmn}
CO1	4.88 ^{ijk}	5.19 ^{fghijk}	5.03 ^{klmn}
ST1	5.50 ^{fghij}	7.27 ^{def}	6.39 ^{efgh}
SR1	4.50 ^{jk}	7.13 ^{defg}	5.82 ^{ghijk}
SG1	4.88 ^{ijk}	8.21 ^{cd}	6.55 ^{efg}
SO1	5.38 ^{ghijk}	8.77 ^{bcd}	7.08 ^{def}
BT2	5.97 ^{defgh}	11.89 ^a	8.94 ^{abc}
BR2	4.69 ^{jk}	10.14 ^{abc}	7.42 ^{de}
BG2	5.41 ^{ghij}	7.96 ^{cde}	6.68 ^{efg}
BO2	4.50 ^{jk}	11.52 ^a	8.02 ^{cd}
CT2	6.63 ^{cde}	4.54 ^{klm}	5.59 ^{ghijklm}
CR2	4.75 ^{jk}	4.65 ^{ijkl}	4.7 ^{lmno}
CG2	4.88 ^{ijk}	5.73 ^{efghijk}	5.31 ^{hijklmn}
CO2	5.00 ^{hijk}	5.56 ^{fghijk}	5.28 ^{ijklmn}
ST2	6.63 ^{cde}	11.84 ^a	9.24 ^{ab}
SR2	4.63 ^{jk}	6.65 ^{defghi}	5.64 ^{ghijkl}
SG2	5.38 ^{ghijk}	6.73 ^{defghi}	6.06 ^{fghijk}
SO2	6.13 ^{defg}	10.23 ^{abc}	8.18 ^{bcd}
BT3	6.66 ^{cde}	7.92 ^{cde}	7.29 ^{de}
BR3	4.50 ^{jk}	4.67 ^{hijkl}	4.59 ^{mno}
BG3	4.78 ^{jk}	10.00 ^{abc}	7.39 ^{de}
BO3	7.38 ^{bc}	11.42 ^{ab}	9.39 ^a
CT3	4.38 ^k	5.13 ^{fghijk}	4.76 ^{lmno}
CR3	4.63 ^{jk}	4.77 ^{hijkl}	4.70 ^{lmno}
CG3	6.50 ^{cdef}	6.54 ^{defghij}	6.53 ^{efg}
CO3	6.75 ^{cde}	4.96 ^{ghijkl}	5.86 ^{ghijk}
ST3	4.50 ^{jk}	10.31 ^{abc}	7.41 ^{de}
SR3	6.50 ^{cdef}	6.78 ^{defgh}	6.64 ^{efg}
SG3	9.50 ^a	10.54 ^{abc}	10.02 ^a
SO3	8.75 ^a	7.21 ^{def}	7.98 ^{cd}

Means followed by the same alphabet do not differ significantly by DMRT at 5%

Table 6.1. Interaction between various parameters and trap catches of *B. correcta* during fruiting period in mango

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	5.59	5.88	5.06	5.51 ^b
Medium	5.14	5.31	5.69	5.38 ^b
Big	5.83	5.56	7.31	6.24 ^a
Mean	5.52 ^b	5.58 ^b	6.02 ^a	5.71

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	6.99	4.75	5.33	4.96	5.51 ^b
Medium	6.41	4.69	5.22	5.21	5.38 ^b
Big	5.18	5.21	6.93	7.63	6.24 ^a
Mean	6.19 ^a	4.88 ^c	5.83 ^b	5.93 ^b	5.71

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	6.58	4.65	5.35	5.50	5.52 ^b
Cylinder	6.46	4.79	5.54	5.54	5.58 ^b
Sphere	5.54	5.21	6.58	6.75	6.02 ^a
Mean	6.19 ^a	4.88 ^c	5.83 ^b	5.93 ^b	5.71

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Interaction between colour and size

Colour significantly affected the response of fruit flies with fruit fly captures in transparent traps being significantly greater (6.19 fruit flies/trap/day) followed by green and orange which were at par with each other. Red colour was least attractive. Similarly colour and size of traps together significantly influenced the trap catches with lowest and highest fruit flies of 4.69 and 7.63 in medium red and big orange traps, respectively (Table 6.1).

Interaction between colour and shape

Traps of different colour and shape together influenced the trap catches significantly with lowest catch (4.65 fruit flies/trap/day) in red bottle and highest of 6.75 fruit flies/trap/day in orange sphere (Table 6.1).

Response of *B. correcta* during non-fruiting period in mango

Medium transparent and orange bottle (BT2 and BO2), and medium transparent sphere (ST2) attracted significantly higher fruit flies (11.52 to 11.89 trap/day) which were at par with the trap catches in BR2, SO2, BG3, BO3, ST3, and SG3. Small green bottle (BG1) was significantly inferior with 3.03 fruit flies/trap/day (Table 6).

Interaction between shape and size

Trap catches were significantly high in medium trap (8.12 fruit flies) followed by big (7.52 fruit flies) and small (5.84 fruit flies) traps. Spheres attracted significantly more fruit flies (8.50 fruit flies/trap/day) followed by bottles (7.84) and cylinders (5.20 fruit flies/trap/day). Size and shape of the trap together influenced the trap catches significantly with highest catches in medium bottle (10.38 fruit flies) and lowest in small bottle (4.66 fruit flies) (Table 6.2).

Table 6.2. Interaction between various parameters and trap catches of *B. correcta* during non-fruiting period in mango

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	4.66	5.03	7.84	5.84 ^c
Medium	10.38	5.12	8.86	8.12 ^a
Big	8.50	5.35	8.71	7.52 ^b
Mean	7.84 ^b	5.20 ^c	8.50 ^a	7.16

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	5.65	5.36	5.48	6.88	5.84 ^c
Medium	9.42	7.14	6.81	9.10	8.12 ^a
Big	7.79	5.40	9.03	7.86	7.52 ^b
Mean	7.62 ^b	5.97 ^d	7.10 ^c	7.95 ^a	7.16

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	8.47	6.04	6.99	9.88	7.84 ^b
Cylinder	4.58	5.03	5.82	5.23	5.20 ^c
Sphere	9.81	6.85	8.49	8.73	8.50 ^a
Mean	7.62 ^b	5.97 ^d	7.10 ^c	7.95 ^a	7.16

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Interaction between colour and size

Orange traps attracted significantly more fruit flies (7.95) and lowest number of fruit flies (5.97) were attracted in red traps. Colour and size of the trap together influenced the trap catch significantly with small red and medium transparent trap attracting lowest (5.36) and highest (9.42) number of fruit flies, respectively (Table 6.2).

Interaction between colour and shape

Colour and shape of the trap together influenced the trap catches significantly with lowest trap catch in transparent cylinder (4.58 fruit flies /trap/day) and highest catch in orange bottle (9.88 fruit flies) (Table 6.2).

Response of *B. correcta* during fruiting and non-fruiting periods in mango (pooled)

The most attractive traps to *B. correcta* were big green sphere (SG3) and big orange bottle (BO3) with fruit fly capture of 10.02 and 9.39 fruit flies/trap/day, respectively, which was on par with trap catches of medium transparent sphere (ST2) and bottle (BT2) attracting 9.24 and 8.94 fruit flies/trap/day, respectively. Lowest catches were recorded in small red bottle (BR1) (4.03 fruit flies/trap/day) (Table 6).

Interaction between shape and size

Captures of fruit flies were greater in medium (6.75 fruit flies/trap/day) and big traps (6.88 fruit flies/trap/day). Spherical traps attracted significantly more fruit flies (7.25 fruit flies/trap/day) followed by bottle traps (6.68 fruit flies/trap/day) and cylinders (5.38 fruit flies/trap/day). Shape and size of the trap together had significant influence on trap catches with lowest (5.12) and highest (8.01) fruit flies in small bottle and big sphere, respectively (Table 6.3).

Table 6.3. Interaction between various parameters and trap catches of *B. correcta* during fruiting and non-fruiting periods in mango (Pooled)

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	5.12	5.46	6.46	5.68 ^b
Medium	7.76	5.22	7.28	6.75 ^a
Big	7.17	5.46	8.01	6.88 ^a
Mean	6.68 ^b	5.38 ^c	7.25 ^a	6.44

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	6.32	5.06	5.41	5.92	5.68 ^b
Medium	7.92	5.92	6.01	7.16	6.75 ^a
Big	6.49	5.31	7.98	7.74	6.88 ^a
Mean	6.91 ^a	5.43 ^c	6.47 ^b	6.94 ^a	6.44

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	7.53	5.35	6.17	7.69	6.68 ^b
Cylinder	5.52	4.91	5.69	5.39	5.38 ^c
Sphere	7.68	6.03	7.54	7.74	7.25 ^a
Mean	6.91 ^a	5.43 ^c	6.47 ^b	6.94 ^a	6.44

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Interaction between colour and size

Trap catches in orange and transparent traps were significantly more with 6.94 and 6.91 fruit flies/trap/day, respectively, followed by green trap (6.47 fruit flies/trap/day). Trap catches were significantly influenced by the combined effect of colour and size of the trap with small red trap attracting lowest (5.06) and big green trap with highest (7.98) catches (Table 6.3).

Interaction between colour and shape

Colour and shape of the trap together had significant influence on trap catches with lowest catch in red cylinder (4.91 fruit flies/trap/day) and highest trap catch of 7.74 fruit flies/trap/day in orange sphere (Table 6.3).

Response of *B. zonata* during fruiting period in mango

Trap attraction of both medium and big transparent bottle (BT2 and BT3) was significantly higher with 1.13 fruit flies/trap/day which was on par with BR2 (0.91 fruit flies/trap/day) and SO3 (0.88 fruit flies/trap/day). Response of fruit flies to small green sphere (SG1) was significantly less (0.13 fruit flies/trap/day) (Table 7).

Interaction between shape and size

Bottle trap was the most attractive with 0.62 fruit flies/trap/day. Cylinders and spheres were the next best but equal with each other. Trap attraction in medium and large traps was significantly more and were on par with each other (0.57 and 0.54 fruit flies/trap/day, respectively). Shape and size of traps together had significant influence on trap catches with small spheres and medium bottles attracting lowest (0.29) and highest (0.77) fruit flies, respectively (Table 7.1).

Table 7. Response of *B. zonata* to different types of traps in mango during different periods at Dharwad .

Treatments	Mean trap catch/day/trap during		
	Fruiting	Non-fruiting	Pooled
BT1	0.35 ^{defg}	0.29 ^{ghi}	0.33 ^{cdefghi}
BR1	0.47 ^{def}	0.19 ⁱ	0.29 ^{fghi}
BG1	0.47 ^{def}	0.23 ⁱ	0.29 ^{fghi}
BO1	0.38 ^{defg}	0.25 ^{hi}	0.25 ^{hi}
CT1	0.66 ^{bcd}	0.32 ^{efghi}	0.44 ^{bcdefghi}
CR1	0.35 ^{defg}	0.23 ⁱ	0.27 ^{ghi}
CG1	0.38 ^{defg}	0.29 ^{ghi}	0.37 ^{bcdefghi}
CO1	0.47 ^{def}	0.23 ⁱ	0.41 ^{bcdefghi}
ST1	0.44 ^{defg}	0.39 ^{defghi}	0.40 ^{bcdefghi}
SR1	0.44 ^{defg}	0.56 ^{abcdef}	0.47 ^{bcdefgh}
SG1	0.13 ^g	0.44 ^{cdefghi}	0.31 ^{efghi}
SO1	0.16 ^{fg}	0.71 ^{ab}	0.24 ⁱ
BT2	1.13 ^a	0.52 ^{abcdefg}	0.81 ^a
BR2	0.91 ^{ab}	0.25 ^{hi}	0.60 ^{ab}
BG2	0.63 ^{bcde}	0.57 ^{abcde}	0.50 ^{bcdefgh}
BO2	0.41 ^{defg}	0.71 ^{ab}	0.31 ^{defghi}
CT2	0.38 ^{defg}	0.19 ⁱ	0.28 ^{ghi}
CR2	0.44 ^{defg}	0.31 ^{fghi}	0.33 ^{cdefghi}
CG2	0.41 ^{defg}	0.38 ^{defghi}	0.41 ^{bcdefghi}
CO2	0.63 ^{bcde}	0.57 ^{abcde}	0.49 ^{bcdefg}
ST2	0.47 ^{def}	0.39 ^{defghi}	0.47 ^{bcdefgh}
SR2	0.63 ^{bcde}	0.36 ^{efghi}	0.55 ^{bcde}
SG2	0.32 ^{efg}	0.63 ^{abcd}	0.32 ^{defghi}
SO2	0.44 ^{defg}	0.75 ^{ab}	0.42 ^{bcdefghi}
BT3	1.13 ^a	0.34 ^{efghi}	0.60 ^{ab}
BR3	0.32 ^{efg}	0.36 ^{efghi}	0.24 ⁱ
BG3	0.59 ^{cde}	0.34 ^{efghi}	0.51 ^{bcdef}
BO3	0.66 ^{bcd}	0.50 ^{bcdefgh}	0.51 ^{bcdef}
CT3	0.41 ^{defg}	0.39 ^{defghi}	0.27 ^{ghi}
CR3	0.35 ^{defg}	0.29 ^{ghi}	0.37 ^{bcdefghi}
CG3	0.47 ^{def}	0.55 ^{abcdef}	0.36 ^{bcdefghi}
CO3	0.44 ^{defg}	0.32 ^{efghi}	0.43 ^{bcdefghi}
ST3	0.16 ^{fg}	0.67 ^{abc}	0.34 ^{cdefghi}
SR3	0.66 ^{bcd}	0.52 ^{bcdefg}	0.59 ^{abc}
SG3	0.47 ^{def}	0.77 ^a	0.58 ^{abcd}
SO3	0.88 ^{abc}	0.55 ^{bcdef}	0.61 ^{ab}

Means followed by the same alphabet do not differ significantly by DMRT at 5%

Table 7.1. Interaction between various parameters and trap catches of *B. zonata* during fruiting period in mango

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.42	0.46	0.29	0.39 ^b
Medium	0.77	0.46	0.46	0.57 ^a
Big	0.67	0.41	0.54	0.54 ^a
Mean	0.62 ^a	0.45 ^b	0.43 ^b	0.50

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.48	0.42	0.33	0.34	0.39 ^b
Medium	0.66	0.66	0.45	0.49	0.57 ^a
Big	0.56	0.44	0.51	0.66	0.54 ^a
Mean	0.57 ^a	0.51 ^a	0.43 ^a	0.50 ^a	0.50

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.87	0.57	0.56	0.48	0.62 ^a
Cylinder	0.48	0.38	0.42	0.51	0.45 ^b
Sphere	0.36	0.57	0.31	0.49	0.43 ^b
Mean	0.57 ^a	0.51 ^a	0.43 ^a	0.50 ^a	0.50

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

Among various coloured traps, the trap catches varied from 0.43 to 0.57 fruit flies/trap/day but did not differ significantly. However both colour and size of the trap together influenced the trap catches with 0.33 in small green and 0.66 fruit flies/trap/day in medium red and transparent and big orange traps (Table 7.1).

Interaction between colour and shape

Colour and shape of trap together influenced trap catches significantly with lowest catches in green sphere (0.31 fruit flies/trap/day) and highest in transparent bottle (0.87 fruit flies/trap/day) (Table 7.1).

Response of *B. zonata* during non-fruiting period in mango

Big green sphere (SG3) attracted significantly more fruit flies (0.77) which however was on par with SR1, SO1, BT2, BG2, BO2, CO2, SG2, SO2, CG3 and ST3. Lower number of fruit flies were trapped in BR1, BG1, CR1, CO1 and CT2 (0.19 to 0.23 fruit flies/trap/day) (Table 7).

Interaction between shape and size

Mean trap catches were significantly higher in medium and big traps (0.47 fruit flies/trap/day) than in small traps (0.35 fruit flies/ trap/day). Spheres attracted highest number of fruit flies (0.56) while cylinders and bottles were at par with each other attracting 0.34 and 0.38 fruit flies/trap/day, respectively. Shape and size of the trap had no combined effect on trap catches (7.2).

Interaction between colour and size

Orange and green traps attracted more fruit flies (0.51 and 0.46 fruit flies/trap/day) while transparent and red were the next best efficient (0.34 and 0.39 fruit flies/trap/day)

Table 7.2. Interaction between various parameters and trap catches of *B. zonata* during non-fruiting period in mango

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.24	0.27	0.53	0.35 ^b
Medium	0.51	0.36	0.53	0.47 ^a
Big	0.38	0.39	0.63	0.47 ^a
Mean	0.38 ^b	0.34 ^b	0.56 ^a	0.43

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.34	0.33	0.32	0.40	0.35 ^b
Medium	0.37	0.31	0.52	0.68	0.47 ^a
Big	0.47	0.39	0.55	0.45	0.47 ^a
Mean	0.39 ^b	0.34 ^b	0.46 ^a	0.51 ^a	0.43

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.38	0.27	0.38	0.49	0.38 ^b
Cylinder	0.30	0.28	0.40	0.37	0.34 ^b
Sphere	0.49	0.48	0.61	0.67	0.56 ^a
Mean	0.39 ^b	0.34 ^b	0.46 ^a	0.51 ^a	0.43

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

traps which did not differ among themselves. Colour and size of the trap together had significant influence on trap catches with lowest catch in medium red trap (0.31 fruit flies/trap/day) and highest in medium orange trap (0.68 fruit flies/trap/day) (Table 7.2).

Interaction between colour and shape

Trap catches were not influenced by the combined effect of colour and shape of the trap, as the trap catches which ranged from 0.27 fruit flies in red bottle to 0.67 fruit flies in orange sphere did not differ significantly (Table 7.2).

Response of *B. zonata* during fruiting and non-fruiting periods in mango (pooled)

Highest capture was recorded in medium transparent bottle (BT2) (0.81 fruit flies/trap/day) which was on par with big red (SR3), green (SG3) and orange spheres (SO3), big transparent (BT3) and medium red bottle (BR2) (0.58 to 0.61 fruit flies/trap/day). Small orange sphere (SO1) and big red bottle (BR3) attracted lowest catches of 0.24 fruit flies/trap/day (Table 7).

Interaction between shape and size

Medium and bigger traps were more effective with 0.46 and 0.45 fruit flies/trap/day. Spheres and bottle traps were equally but significantly more attractive with 0.44 fruit flies/trap/day. Shape and size of the trap together had significant influence on trap catches with lowest (0.29) and highest (0.55) catches in small and medium bottle traps, respectively (Table 7.3).

Interaction between colour and size

Different coloured traps had no influence in attracting fruit flies. However colour and size of the trap together had significant influence with small orange trap attracting

Table 7.3. Interaction between various parameters and trap catches of *B. zonata* during fruiting and non-fruiting periods in mango (Pooled)

Size and Shape

↓Size/shape→	Mean catches/day/trap in			
	Bottle	Cylinder	Sphere	Mean
Small	0.29	0.37	0.36	0.34 ^b
Medium	0.55	0.37	0.44	0.46 ^a
Big	0.46	0.36	0.53	0.45 ^a
Mean	0.44 ^a	0.37 ^b	0.44 ^a	0.41

Colour and Size

↓Size/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Small	0.39	0.34	0.32	0.30	0.34 ^b
Medium	0.52	0.49	0.41	0.41	0.46 ^a
Big	0.40	0.40	0.48	0.52	0.45 ^a
Mean	0.43 ^a	0.41 ^a	0.40 ^a	0.41 ^a	0.41

Colour and Shape

↓Shape/Colour→	Mean catches/day/trap in				
	Transparent	Red	Green	Orange	Mean
Bottle	0.58	0.37	0.43	0.36	0.44 ^a
Cylinder	0.33	0.32	0.38	0.44	0.37 ^b
Sphere	0.40	0.53	0.40	0.42	0.44 ^a
Mean	0.43 ^a	0.41 ^a	0.40 ^a	0.41 ^a	0.41

Means followed by the same alphabet in rows and columns do not differ significantly by DMRT at 5%

lowest number of fruit flies (0.30) and medium transparent trap with highest number of fruit flies (0.52 fruit flies/trap/day) (Table 7.3).

Interaction between colour and shape

Colour and shape of the trap together had significant influence with lowest catch in red cylinder (0.32 fruit flies/trap/day) and highest in transparent bottle (0.58 fruit flies/trap/day) (Table 7.3).

4.1.2 Experiment-2: Evaluation of different coloured methyl eugenol traps in attracting fruit flies in guava orchard at Hosaritti

Response of *B. dorsalis*

During the first month of the test period, fruit fly captures varied significantly among different coloured traps with greater catches in orange trap (71.4 fruit flies/trap/month). Transparent trap recorded the next higher catch with 53.6 fruit flies/trap/week/month. The response of fruit flies to green and red colour was on par and these two colours attracted less number of flies (25.2 and 23.0 fruit flies/trap/month respectively) (Table 8).

No preference to any colour was observed in the second trapping period with all colours being equally attractive with 6.0, 5.2, 5.8 and 5.2 fruit flies/trap/month in transparent, orange, red and green coloured traps, respectively.

During the third trapping period, colour significantly affected the response of fruit flies. Highest capture (17.00 fruit flies) was obtained in orange coloured traps followed by red (12.00 fruit flies) and transparent (11.8 fruit flies) traps. Number of fruit flies caught in green traps remained low (8.00 fruit flies) (Table 8).

Table 8. Response of *B. dorsalis* to different coloured methyl eugenol traps in guava orchard at Hosaritti

Treatments	Fruit flies/trap/month			
	I month	II month	III month	Mean
T ₁ Green	25.2c	5.2a	8.00c	12.8 ^c
T ₂ Red	23.0c	5.8a	12.00b	13.6 ^c
T ₃ Orange	71.4a	5.2a	17.00a	31.2 ^a
T ₄ Transparent	53.6b	6.0a	11.8b	23.8 ^b

Means followed by the same alphabet in columns do not differ significantly by DMRT at 5%

Table 9. Response of *B. correcta* to different coloured methyl eugenol traps in guava orchard at Hosaritti

Treatments	Fruit flies/trap/month			
	I month	II month	III month	Mean
T ₁ Green	13.0c	78.00c	87.8c	59.60 ^c
T ₂ Red	2.8d	111.00b	243.0b	118.93 ^b
T ₃ Orange	29.8a	133.60a	299.4a	154.27 ^a
T ₄ Transparent	22.20b	68.40c	90.8c	60.47 ^c

Means followed by the same alphabet in columns do not differ significantly by DMRT at 5%

Orange coloured trap attracted significantly more fruit flies with mean capture of 31.2 fruit flies followed by transparent trap (23.8 fruit flies). Mean trap catches in green and red traps did not vary.

Response of *B. correcta*

In the first month of study period, fruit flies showed a significant preference for orange coloured traps over others with 29.8 fruit flies/trap/month. The next best capture was obtained in transparent colour (22.20 fruit flies) followed by green (13.0 fruit flies). In the second month, orange coloured traps caught the largest number of fruit flies (133.60) whereas green and transparent caught the lowest catches of 68.40 and 78.00, respectively which were on par with each other (Table 9).

During the third trapping period also, the same trend in trap efficiency was obtained with orange colour recording significantly more trap catch (299.4).

Mean trap catches were significantly high in orange trap (154.27 fruit flies) followed by red trap (118.93 fruit flies). Transparent and green traps were at par with each other with mean catches of 60.47 and 59.6 fruit flies, respectively.

4.1.3 Experiment-3: Evaluation of commercial traps in attracting fruit flies in mixed orchard at Navalur

Response of *B. cucurbitae*

During a series of six weeks trapping period, Fligh-T™ trap outperformed the other two traps except in the 2nd week. Mean trap catch in Fligh-T™ trap was significantly high (12.50 fruit flies) compared to modified Steiner trap (5.47 fruit flies). The Fligh-T™ trap attracted maximum of 20.17 fruit flies in the 5th week and minimum of 3.17 fruit flies

in the first trapping period. Similarly, maximum and minimum trap catches in modified steiner trap were 8.83 (5th week) and 1.67 fruit flies (1st week). Del-Ta trap was not efficient and did not attract any fruit fly (Table 10).

Response of *B. dorsalis*

Fligh-T™ trap consistently captured more fruit flies in all the test periods with a mean capture of 4.14 fruit flies/week. The highest and lowest capture was obtained during 5th and first week with 7.17 and 1.67 fruit flies/trap/week, respectively. Lower trap catch was observed in modified Steiner trap with mean capture of 2.58 fruit flies/trap/week. However mean trap catches in Fligh-T™ and modified Steiner trap did not differ statistically. Maximum and minimum trap catch was 4.33 and 1.33 during 4th and 6th week. Fruit flies did not show any response to Del-Ta trap (Table 11).

4.2 SPECIES COMPLEX AND RELATIVE ABUNDANCE OF DIFFERENT SPECIES OF FRUIT FLIES IN GUAVA AND MANGO

4.2.1 Species complex and relative abundance of different species of fruit flies in methyl eugenol traps in guava orchards at Dharwad and Hosaritti

Three species of fruit flies namely, *B. dorsalis*, *B. correcta* and *B. zonata* were recorded in the orchards at the University of Agricultural Sciences, Dharwad (UAS, Dharwad) (Table 12 and Plate 6). At Hosaritti also these three species were recorded. In both locations, *B. correcta* was the dominant with per cent relative abundance of 88.93 and 78.04 at UAS, Dharwad and Hosaritti respectively. *B. dorsalis* was the next dominant fruit fly at UAS, Dharwad (6.34%) and Hosaritti (19.49%) followed by *B. zonata* (4.73% and 2.47%, respectively).

Table 10. Evaluation of commercial traps in attracting *B. cucurbitae* in mixed orchard at Navalur

Treatments	Fruit flies/trap/week						
	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	Mean
1. Fligh-T™ trap	3.17	5.0	17.83	16.50	20.17	12.33	12.50
2. Modified Steiner trap	1.67	5.50	4.50	8.50	8.83	3.83	5.47
3. Del-Ta trap #	0.0	0.0	0.0	0.0	0.0	0.0	0.0
t value between 1 & 2							2.279*

Since trap catches were nil, this trap was not considered for analysis

* Significant at 5%

Table 11. Evaluation of commercial traps in attracting *B. dorsalis* in mixed orchard at Navalur

Treatments	Fruit flies/trap/week						
	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	Mean
1. Fligh-T™ trap	1.67	3.5	2.83	5.50	7.17	4.17	4.14
2. Modified Steiner trap	1.50	2.50	2.50	4.33	3.33	1.33	2.58
3. Del-Ta trap #	0.00	0.00	0.00	0.00	0.00	0.00	0.00
t value between 1 & 2							NS

Since trap catches were nil, this trap was not considered for analysis

Table 12. Species complex of fruit flies and their relative abundance in methyl eugenol traps in guava orchard at Dharwad and Hosaritti

Species	Per cent relative abundance at	
	UAS Dharwad	Hosaritti
<i>B. dorsalis</i>	6.34	19.49
<i>B. correcta</i>	88.93	78.04
<i>B. zonata</i>	4.73	2.47

Table 13. Species complex of fruit flies and their relative abundance in methyl eugenol traps in mango orchard at Dharwad

Species	Per cent relative abundance
<i>B. dorsalis</i>	5.49
<i>B. correcta</i>	89.29
<i>B. zonata</i>	5.22

Table 14. Species complex of fruit flies and their relative abundance in methyl eugenol and cue lure traps in mixed orchard at Navalur

Species	Per cent relative abundance in traps with	
	Methyl eugenol	Cuelure
<i>B. dorsalis</i>	10.53	29.11
<i>B. correcta</i>	87.30	-
<i>B. zonata</i>	2.17	-
<i>B. cucurbitae</i>	-	70.34
<i>Dacus</i> sp.	-	0.55



B. dorsalis



B. correcta



B. zonata

Plate 6: Fruit flies (males) attracted to methyl eugenol traps

4.2.2 Species complex and relative abundance of different species of fruit flies in methyl eugenol traps in mango orchard at Dharwad

Three species of fruit flies of the genus *Bactrocera* viz., *dorsalis*, *correcta* and *zonata* were trapped in mango orchard at UAS, Dharwad. *B. correcta* was the dominant species with per cent relative abundance of 89.29 followed by *B. dorsalis* (5.49) and *B. zonata* (5.22) (Table 13).

4.2.3 Species complex and relative abundance of different species of fruit flies in methyl eugenol and cuelure traps in mixed orchard at Navalur

At Navalur also, *B. dorsalis*, *B. correcta* and *B. zonata* were trapped in methyl eugenol traps with *B. correcta* having 87.3 per cent relative abundance. *B. dorsalis* was the next dominant fruit fly (10.53%) followed by *B. zonata* (2.17%).

In cuelure traps, two species of genus *Bactrocera* (*B. dorsalis* and *B. cucurbitae*) and one *Dacus* sp. were trapped (Plate 7). *B. cucurbitae* was the dominant with per cent relative abundance of 70.34 followed by *B. dorsalis* (29.11). *Dacus* sp. was the least dominant with per cent relative abundance of 0.55 (Table 14).

4.3 MONITORING OF DIFFERENT SPECIES OF FRUIT FLIES TRAPS IN GUAVA AND MANGO

4.3.1 Monitoring of different species of fruit flies through methyl eugenol traps in guava orchard at Dharwad

Studies on population fluctuation of fruit flies were carried out in guava orchard at UAS, Dharwad from July 2003 to March 2004.

In 2003, population of *B. dorsalis* was recorded throughout the year. The fruit fly population gradually increased from 27th standard week (12.32 fruit flies/trap/week) to 30th



B. dorsalis



B. cucurbitae



Dacus sp.

Plate 7: Fruit flies (males) attracted to cuelure traps

standard week reaching a peak of 27.16 fruit flies/trap/week. Later, the population declined reaching a lowest level of 0.42 fruit flies in 46th standard week and it remained more or less at the same level till 49th week (Table 15).

In 2004, maximum population was observed during 1st standard week (2.03 fruit flies/trap/week) and thereafter a declining trend was recorded.

Population of *B. correcta* which was 32.55 fruit flies/trap/week during 27th standard week reached a small peak of 123.69 fruit flies during 30th week. A declining trend was observed in fruit fly population during August, 2003 which reached a lowest level in last week of August (6.3 fruit flies/trap/week). However, the population gradually increased from 41st standard week reaching a highest peak of 362.67 fruit flies/trap/week during 45th standard week in 2003. Then again the population started declining from first week of December 2003 upto 4th week of March 2004, reaching a lowest level of 20.44 flies/trap/day during 8th standard week of 2004 (Table 15) .

Population of *B. zonata* remained at a very low level throughout the year with maximum number of fruit flies (15.19 fruit flies/trap/week) during 42nd standard week in 2003. In 2004, relatively more number of fruit flies was recorded during 7th, 8th, 11th and 12th standard weeks with 16.94 to 17.71 fruit flies/trap/week, and thereafter the population declined (Table 15).

When the total number of fruit flies irrespective of the species was considered, the population which was 52.64 fruit flies/trap/week during 27th standard week, reached a small peak of 157.64 fruit flies during 30th standard week. Then the fruit fly activity was regained reaching a second peak of 218.75 fruit flies during 43rd week. However the highest peak of 379.82 fruit flies was observed during 45th standard week. In 2004, the major peak was observed during 3rd (107.1 fruit flies) standard week (Table 15) .

Table 15. Monitoring of different species of fruit flies through methyl eugenol traps in guava orchard at UAS, Dharwad

Standard weeks and dates	Number of fruit flies trapped/week			Total fruit flies/week
	<i>B. dorsalis</i>	<i>B. correcta</i>	<i>B. zonata</i>	
2003				
27 July 2-8	12.32	32.55	7.77	52.64
28 July 9-15	16.8	26.74	7.21	50.75
29 July 16-22	14.42	72.66	5.11	92.19
30 July 23-29	27.16	123.69	6.79	157.64
31 Aug 30-5	17.29	28.00	7.84	53.13
32 Aug 6-12	6.09	6.58	2.1	14.77
33 Aug 13-19	6.58	12.25	1.19	20.02
34 Aug 20-26	3.99	8.26	0.91	13.16
35 Aug 27-3	7.0	6.3	2.03	15.33
36 Sep 4-10	4.13	7.7	1.96	13.86
37 Sep 11-17	6.72	7.56	1.54	15.82
38 Sep 18-24	5.95	7.07	1.26	14.28
39 Sep 25-1	3.78	19.04	0.42	23.24
40 Oct 2-8	0.21	26.95	0.42	27.58
41 Oct 9-15	1.19	100.94	9.31	111.44
42 Oct 16-22	2.94	158.76	15.19	176.89
43 Oct 23-29	2.66	213.57	2.52	218.75
44 Nov 30-5	2.31	133.49	2.45	138.25
45 Nov 6-12	5.32	362.67	11.83	379.82
46 Nov 13-19	0.42	53.27	2.38	56.07
47 Nov 20-26	0.42	116.13	0.49	117.04
48 Nov 27-3	0.49	123.13	1.68	125.30
49 Dec 4-10	0.42	86.52	0.63	87.57
50 Dec 11-17	2.66	72.8	0.77	76.23
51 Dec 18-24	2.24	85.33	1.19	88.76
52 Dec 25-31	0.42	86.24	0.91	87.57
2004				
1 Jan 1-7	2.03	85.33	0.98	88.34
2 Jan 8-14	1.19	60.27	0.21	61.67
3 Jan 15-21	1.75	98.77	6.58	107.1
4 Jan 22-28	0.77	67.27	2.73	70.77
5 Jan 29-4	1.33	57.54	3.92	62.79
6 Feb 5-11	0.77	40.18	2.52	43.47
7 Feb 12-18	0.42	38.29	16.94	55.65
8 Feb 19-25	0.42	20.44	16.94	37.80
9 Feb 26-3	0.07	33.32	2.17	35.56
10 Mar 4-10	0.98	30.31	14.28	45.57
11 Mar 11-17	1.54	32.27	17.71	51.52
12 Mar 18-24	1.54	32.48	17.71	51.73
13 Mar 25-31	1.68	28.98	6.02	36.68

4.3.2 Monitoring of different species of fruit flies through methyl eugenol traps in guava orchard at Hosaritti

At Hosaritti, fruit fly population was monitored from 34th standard week to 45th standard week of 2003 (Table 16).

Only one major peak of *B. dorsalis* was recorded during the initial study period (34th week) with 20.3 fruit flies/trap/week. Thereafter, decrease in population was recorded with a lowest population of 1.25 fruit flies/trap/week during 41st standard week.

In case of *B. correcta*, population gradually increased from 38th standard week with two major peaks during 44th (75.50 fruit flies) and 45th standard weeks (70.50 fruit flies).

Population of *B. zonata* was very low and varied from 0.05 in 35th standard week to 1.15 fruit flies during 40th and 42nd standard weeks (Table 16).

4.3.3 Monitoring of different species of fruit flies through methyl eugenol traps in mango orchard at Dharwad

In mango orchard at UAS, Dharwad, population of *B. dorsalis* was recorded throughout the year (Table 17). The population which was 8.33 fruit flies/trap during 27th standard week in 2003, reached a major peak of 22.47 fruit flies during 30th standard week. Later the population declined and remained at a low level with slight fluctuations. In 2004, population remained at a very low level with small peaks of 2.17, 2.52 and 5.04 fruit flies, during 4th, 12th and 13th standard weeks.

In 2003, population of *B. correcta* which was 9.94 fruit flies/trap/week during 27th standard week, first reached a small peak of 92.82 fruit flies during 29th week. The population declined and remained at low level till 38th week. From 39th standard week, the

Table 16. Monitoring of different species of fruit flies through methyl eugenol traps in guava orchard at Hosaritti

Standard weeks and date	Fruit flies/trap/week		
	<i>B. dorsalis</i>	<i>B. correcta</i>	<i>B. zonata</i>
2003			
34 Aug. 20-26	20.3	7.7	0.85
35 Aug. 27-3	9.15	3.75	0.05
36 Sep. 4-10	3.8	1.15	0.15
37 Sep. 11-17	3.85	1.20	0.05
38 Sep. 18-24	1.50	18.45	0.45
39 Sep. 25-1	1.35	18.45	0.35
40 Oct. 2-8	1.45	33.50	1.15
41 Oct. 9-15	1.25	27.25	0.75
42 Oct. 16-22	5.9	18.95	1.15
43 Oct. 23-29	4.55	15.30	0.65
44 Oct. 30-5	4.05	75.50	1.05
45 Nov. 6-12	3.20	70.50	1.0

Table 17. Monitoring of different species of fruit flies through methyl eugenol traps in mango orchard at UAS, Dharwad

Standard weeks and date	Number of fruit flies trapped/weeks			Total fruit flies/week
	<i>B. dorsalis</i>	<i>B. correcta</i>	<i>B. zonata</i>	
2003				
27 July 2-8	8.33	9.94	3.29	21.56
28 July 9-15	7.42	11.48	2.45	21.35
29 July 16-22	18.13	92.82	4.06	115.01
30 July 23-29	22.47	89.74	8.68	120.89
31 Aug 30-5	7.21	9.73	1.19	18.13
32 Aug 6-12	4.62	6.02	2.31	12.95
33 Aug 13-19	2.31	6.44	0.77	9.52
34 Aug 20-26	4.27	3.22	0.77	8.26
35 Aug 27-3	8.54	7.07	2.52	18.13
36 Sep 4-10	3.29	2.52	1.33	7.14
37 Sep 11-17	5.53	2.73	1.47	9.73
38 Sep 18-24	4.27	3.43	0.07	7.77
39 Sep 25-1	2.24	27.02	0.28	29.54
40 Oct 2-8	0.28	29.68	0.63	30.59
41 Oct 9-15	0.56	31.50	6.23	38.29
42 Oct 16-22	4.97	202.44	16.8	224.21
43 Oct 23-29	1.96	274.05	4.27	280.28
44 Nov 30-5	2.8	169.33	12.81	184.94
45 Nov 6-12	5.74	341.53	14.42	361.69
46 Nov 13-19	1.47	140.00	2.24	143.71
47 Nov 20-26	0.56	123.06	0.98	124.60
48 Nov 27-3	0.42	108.5	0.42	109.34
49 Dec 4-10	0.07	72.31	0.77	73.15
50 Dec 11-17	2.52	89.67	0.98	93.17
51 Dec 18-24	1.96	81.55	0.07	83.58
52 Dec 25-31	1.54	153.93	2.94	158.41
2004				
1 Jan 1-7	0.07	144.48	0.77	145.32
2 Jan 8-14	0.07	83.58	0.07	83.72
3 Jan 15-21	1.19	133.42	0.77	135.38
4 Jan 22-28	2.17	114.31	9.94	126.42
5 Jan 29-4	0.42	76.51	3.29	80.22
6 Feb 5-11	0.56	65.31	3.29	69.16
7 Feb 12-18	0.77	30.73	1.54	33.04
8 Feb 19-25	0.56	51.80	18.48	70.84
9 Feb 26-3	0.07	30.94	17.01	48.02
10 Mar 4-10	1.33	34.79	7.42	43.54
11 Mar 11-17	1.33	34.79	6.79	42.91
12 Mar 18-24	2.52	31.92	7.98	42.42
13 Mar 25-31	5.04	25.41	16.24	46.69
14 Apr 1-7	2.31	30.17	8.82	41.3

population increased rapidly and reached a major peak of 341.53 fruit flies during 45th standard week. Smaller peaks were recorded during 52nd (153.93 fruit flies) standard week in 2003 and 1st (144.48 fruit flies) and 3rd (133.42 fruit flies) standard weeks in 2004. Population declined from 4th standard week to 30.73 fruit flies during the 7th standard week and remained more or less at the same level till 14th week (Table 17).

Population of *B. zonata* increased from 3.29 fruit flies during 27th week to 8.68 fruit flies during 30th week. It remained at a low level till 40th week (0.07 to 2.52 fruit flies). But the population increased to second peak of 6.80 fruit flies during 42nd and third peak of 14.42 fruit flies during 45th week. Thereafter the population declined. In 2004, two major peaks occurred during 8th (18.48), and 13th (16.24) standard weeks (Table 17).

The total number of fruit flies irrespective of species, reached a highest peak during 45th standard week (361.69 fruit flies/trap/week). Then the population slightly started declining upto 73.15 fruit flies during 49th standard week. Once again a minor peak was observed during 52nd standard week in 2003 and 1st standard week in 2004 with 158.41 and 145.32 fruit flies, respectively. Thereafter, the population declined to 48.02 fruit flies by 9th standard week and remained at the same level till 14th week (Table 17).

4.4 EVALUATION OF PROTEIN FOOD BAITS IN ATTRACTING FEMALE FRUIT FLIES IN GUAVA AND MANGO AT NAVALUR

4.4.1 Evaluation of protein food baits in attracting female fruit flies of different species in guava

Evaluation against *B. dorsalis*

Significantly higher trap catches were recorded in traps baited with yeast + sugar + banana (1:1:1) (T₄) (2.0 fruit flies/trap/week), soybean + sugar + banana (0.5:1:1) (T₁₀)

(2.0 fruit flies), soybean + sugar + papaya (T₂₄) (0.5:1:1) (3.0 fruit flies) and yeast + sugar + papaya (T₂₅) (0.5:1:1) (2.0 fruit flies). Next higher catches were recorded in treatments T₂, T₅, T₁₃, T₁₉ and T₂₂ (Table 18, Plate 8, 9, 10 and 11).

Evaluation against *B. correcta*

Response of *B. correcta* to different food baits was very poor. Protein baits containing soybean + sugar + banana (T₁₀) (0.5:1:1) was the only food bait which showed an indication of attracting more fruit flies (1.5 fruit flies) than the other combinations which were at par with each other (Table 18).

Evaluation against *B. cucurbitae*

Protein food baits containing fruit fly diet + sugar + banana (1:1:1) (T₇), soybean + sugar + banana (0.5:1:1) (T₁₀), protone + sugar + banana (1:1:1) (T₁₆) and casein + sugar + papaya (0.5:1:1) (T₂₇) were the only treatments that attracted more fruit flies (1.0 fruit fly/trap). All other food combinations failed to attract female fruit flies (Table 18).

Evaluation against total female fruit flies

Protein food bait containing soybean + sugar + banana (T₁₀) (0.5:1:1) attracted greater number of fruit flies (4.5 fruit flies). Food baits with soybean + sugar + papaya (T₂₄) and yeast + sugar + papaya (T₂₅) in 0.5:1:1 concentration were the next best bait combination attracting 3.0 fruit flies (Table 18).

4.4.2 Evaluation of protein food baits in attracting female fruit flies of different species in mango

Evaluation against *B. dorsalis*

Traps baited with fruit fly diet + sugar + papaya (1:1:1) (T₁₂) and casein + sugar + papaya (1:1:1) (T₁₃) enticed significantly more female fruit flies (2.33 and 2.08 fruit

Table 18. Evaluation of protein food baits in attracting female fruit flies of different species in guava at Navalur

Treatments	Mean trap catches/trap/week			
	<i>B. dorsalis</i>	<i>B. correcta</i>	<i>B. cucurbitae</i>	Total
T ₁ - Peptone + Sugar + Banana (1:1:1)	0.0c	0.0b	0.0b	0.0d
T ₂ - Protone + Sugar + Banana (1:1:1)	1.5b	0.5b	0.0b	2.0b
T ₃ . Soybean + Sugar + Banana (1:1:1)	0.0c	0.0b	0.0b	0.0d
T ₄ . Yeast + Sugar + Banana (1:1:1)	2.0a	1.0b	0.0b	3.0b
T ₅ . Malt + Sugar + Banana (1:1:1)	1.5b	0.0b	0.0b	1.5c
T ₆ . Casein + Sugar + Banana (1:1:1)	0.0c	0.0b	0.0b	0.0d
T ₇ . Fruit fly diet + Sugar + Banana (1:1:1)	0.0c	0.5b	1.0a	1.5c
T ₈ . Peptone + Sugar + Banana (0.5:1:1)	0.0c	0.0b	0.0b	0.0d
T ₉ . Protone + Sugar + Banana (0.5:1:1)	1.0bc	0.5b	0.0b	1.5c
T ₁₀ . Soybean + Sugar + Banana (0.5:1:1)	2.0a	1.5a	1.0a	4.5a
T ₁₁ . Yeast + Sugar + Banana (0.5:1:1)	1.0bc	1.0b	0.5ab	2.5b
T ₁₂ . Malt + Sugar + Banana (0.5:1:1)	0.0c	0.0b	0.0b	0.0d
T ₁₃ . Casein + Sugar + Banana (0.5:1:1)	1.5b	1.0b	0.0b	2.5b
T ₁₄ . Fruit fly diet + Sugar + Banana (0.5:1:1)	0.0c	0.0b	0.0b	0.0d
T ₁₅ . Peptone + Sugar + Papaya (1:1:1)	1.0bc	0.5b	0.5ab	2.0b
T ₁₆ . Protone + Sugar + Papaya (1:1:1)	0.5bc	0.0b	1.0a	1.5c
T ₁₇ . Soybean + Sugar + Papaya (1:1:1)	1.0bc	0.5b	0.0b	1.5c
T ₁₈ . Yeast + Sugar + Papaya (1:1:1)	1.0bc	0.5b	0.5ab	2.0b
T ₁₉ . Malt + Sugar + Papaya (1:1:1)	1.5b	1.0b	0.0b	2.5b
T ₂₀ . Casein + Sugar + Papaya (1:1:1)	0.0c	0.5b	0.0b	0.5c
T ₂₁ . Fruit fly diet + Sugar + Papaya (1:1:1)	0.5bc	0.0b	0.0b	0.5cd
T ₂₂ . Peptone + Sugar + Papaya (0.5:1:1)	1.5b	0.0b	0.0b	1.5c
T ₂₃ . Protone + Sugar + Papaya (0.5:1:1)	0.0c	0.0b	0.0b	0.0d
T ₂₄ . Soybean + Sugar + Papaya (0.5:1:1)	3.0a	0.0b	0.0b	3.0b
T ₂₅ . Yeast + Sugar + Papaya (0.5:1:1)	2.0a	0.5b	0.5ab	3.0b
T ₂₆ . Malt + Sugar + Papaya (0.5:1:1)	1.0bc	1.0b	0.5ab	2.5b
T ₂₇ . Casein + Sugar + Papaya (0.5:1:1)	1.0bc	0.0b	1.0a	2.0b
T ₂₈ . Fruit fly diet + Sugar + Papaya (0.5:1:1)	0.0c	0.5b	0.0b	0.5cd

Means followed by the same alphabet in a column do not differ significantly by DMRT at 5%



B. dorsalis



B. correcta



B. cucurbitae



B. zonata

Plate 8: Female fruit flies attracted to protein food baits

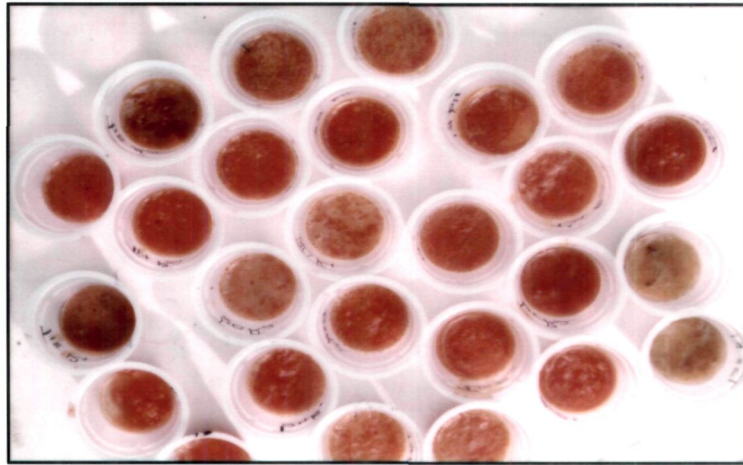


Plate 9: Different protein baits in plastic cups

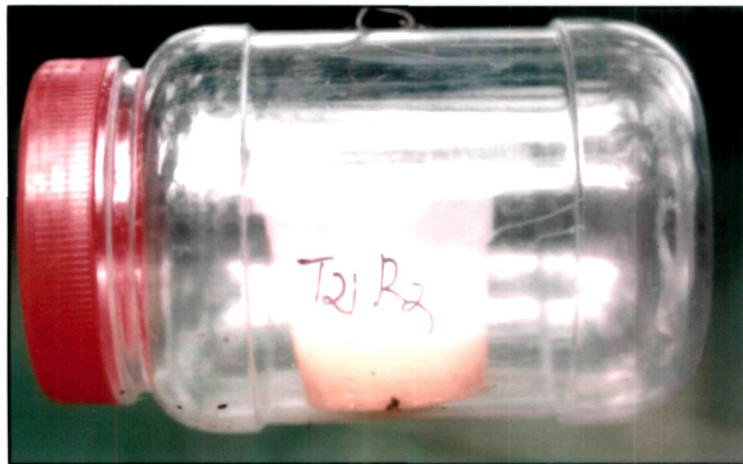


Plate 10: Trap with protein food bait



Plate 11: Protein food bait in mango

flies/trap, respectively) than the other food baits (Table 19). In T₁₂, the attractiveness of food bait containing fruit fly diet + sugar + papaya showed a consistent pattern of increase in attracting female fruit flies ranging from 1.00 to 6.00 from first week to sixth week of test period. Traps baited with casein + sugar + papaya caught more fruit flies only during the sixth sample period (3.0) with a mean trap catch of 2.08.

Traps baited with fruit fly diet + sugar + banana (1:1:1) (T₅) and yeast + sugar + banana (1:1:1) (T₁) were observed to be the second best (1.08 and 1.33 fruit flies).

No capture of fruit flies was obtained with either of the two treatments without protein source *i.e.* papaya + sugar (T₁₅) (1:1) and banana + sugar (T₁₆) (1:1) (Table 19).

Evaluation against *B. cucurbitae*

Traps baited with casein + sugar + papaya (T₁₃) were more female selective with a mean trap catch of 2.17 fruit flies/trap/week (Table 20). Maximum number of fruit flies were trapped during 2nd and 5th trapping period (3.0 fruit flies/trap/week). Combination of fruit fly diet + sugar + papaya (T₁₂), fruit fly diet + sugar + banana (T₅) and protone + sugar + banana (T₇) were the next best treatments in attracting female *B. cucurbitae* with mean trap catches of 1.17, 1.5 and 1.25 fruit flies/trap/week respectively.

Evaluation against total female fruit flies

Casein + sugar + papaya (1:1:1) (T₁₃) was the most superior food bait attracting significantly more number of female fruit flies over an exposure period of six weeks accounting for a mean trap catch of 4.33 fruit flies/trap/week (Table 21) In this treatment, the trap catch was maximum (5.5) during the second week of observation. Fruit fly diet + sugar + papaya (1:1:1) (T₁₂) gave the next best response (3.5) followed by fruit fly diet + sugar + banana (3.0) (T₅). In T₁₂, a second greater proportion of female fruit flies

Table 19. Evaluation of protein food baits in attracting females of *B. dorsalis* in mango at Navalur

Treatments	Fruit flies/trap/week						Mean
	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	
T ₁ - Yeast + Sugar + Banana (1:1:1)	0.5	1.0	0.5	0.5	1.5	4.0	1.33b
T ₂ - Malt + Sugar + Banana (1:1:1)	0.0	0.0	0.0	0.0	0.0	2.0	0.33d
T ₃ - Soybean + Sugar + Banana (1:1:1)	1.5	1.5	0.5	0.5	1.0	0.5	0.92c
T ₄ - Peptone + Sugar + Banana (1:1:1)	0.5	0.5	0.0	0.5	1.0	0.5	0.5d
T ₅ - Fruit fly diet + Sugar + Banana (1:1:1)	1.0	1.5	1.0	1.0	1.5	2.5	1.08b
T ₆ - Casein + Sugar + Banana (1:1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0e
T ₇ - Protone + Sugar + Banana (1:1:1)	1.5	1.0	0.5	0.5	0.5	1.0	0.83c
T ₈ - Yeast + Sugar + Papaya (1:1:1)	0.5	0.5	0.0	0.0	0.0	0.0	0.17e
T ₉ - Malt + Sugar + Papaya (1:1:1)	0.0	0.0	0.0	0.0	0.0	1.0	0.17e
T ₁₀ - Soybean + Sugar + Papaya (1:1:1)	1.0	1.0	0.5	0.5	0.5	0.5	0.67c
T ₁₁ - Peptone + Sugar + Papaya (1:1:1)	0.0	0.0	0.0	0.0	0.0	0.5	0.08e
T ₁₂ - Fruit fly diet + Sugar + Papaya (1:1:1)	1.0	1.0	1.0	2.0	3.0	6.0	2.33a
T ₁₃ - Casein + Sugar + Papaya (1:1:1)	2.5	2.0	1.5	2.0	1.5	3.0	2.08a
T ₁₄ - Protone + Sugar + Papaya (1:1:1)	0.5	0.5	1.5	0.0	0.0	1.5	0.67c
T ₁₅ - Papaya + Sugar (1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0e
T ₁₆ - Banana + Sugar (1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0e

Means followed by the same alphabet in a column do not differ significantly by DMRT at 5%

Table 20. Evaluation of protein food baits in attracting females of *B. cucurbitae* in mango at Navalur

Treatments	Fruit flies/trap/week						
	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	Mean
T ₁ - Yeast + Sugar + Banana (1:1:1)	0.5	1.0	0.5	1.0	1.0	1.0	0.83c
T ₂ - Malt + Sugar + Banana (1:1:1)	0.0	0.0	0.0	0.0	0.0	1.0	0.17d
T ₃ - Soybean + Sugar + Banana (1:1:1)	1.0	1.5	1.0	1.0	1.0	0.5	1.0c
T ₄ - Peptone + Sugar + Banana (1:1:1)	0.0	0.5	0.0	0.0	0.0	0.5	0.17d
T ₅ - Fruit fly diet + Sugar + Banana (1:1:1)	1.0	1.5	1.0	1.5	2.0	2.0	1.5b
T ₆ - Casein + Sugar + Banana (1:1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0d
T ₇ - Protone + Sugar + Banana (1:1:1)	1.0	2.5	0.5	1.5	1.5	0.5	1.25b
T ₈ - Yeast + Sugar + Papaya (1:1:1)	0.5	0.0	0.0	0.0	0.0	1.0	0.25d
T ₉ - Malt + Sugar + Papaya (1:1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0d
T ₁₀ - Soybean + Sugar + Papaya (1:1:1)	0.5	1.0	0.5	1.0	1.0	1.0	0.83c
T ₁₁ - Peptone + Sugar + Papaya (1:1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0d
T ₁₂ - Fruit fly diet + Sugar + Papaya (1:1:1)	0.5	1.0	1.5	1.5	2.0	0.5	1.17b
T ₁₃ - Casein + Sugar + Papaya (1:1:1)	2.0	3.0	2.0	2.0	3.0	1.0	2.17a
T ₁₄ - Protone + Sugar + Papaya (1:1:1)	1.0	0.0	0.5	0.0	0.0	0.0	0.25d
T ₁₅ - Papaya + Sugar (1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0d
T ₁₆ - Banana + Sugar (1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0d

Means followed by the same alphabet in a column do not differ significantly by DMRT at 5%

Table 21. Evaluation of protein food baits in attracting total female fruit flies in mango at Navalur

Treatments	Fruit flies/trap/week						
	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	Mean
T ₁ - Yeast + Sugar + Banana (1:1:1)	1.5	2.5	1.0	1.5	2.5	5.0	2.33d
T ₂ - Malt + Sugar + Banana (1:1:1)	0.0	0.0	0.0	0.0	0.0	3.0	0.5f
T ₃ - Soybean + Sugar + Banana (1:1:1)	2.5	3.0	1.5	2.0	2.0	1.5	2.08d
T ₄ - Peptone + Sugar + Banana (1:1:1)	0.5	1.0	0.0	0.5	1.0	1.0	0.67f
T ₅ - Fruit fly diet + Sugar + Banana (1:1:1)	2.0	3.0	2.5	2.5	3.5	4.5	3.0c
T ₆ - Casein + Sugar + Banana (1:1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0g
T ₇ - Protone + Sugar + Banana (1:1:1)	2.5	3.5	1.0	2.0	2.0	1.5	2.08d
T ₈ - Yeast + Sugar + Papaya (1:1:1)	1.5	0.5	0.0	0.0	0.0	1.0	0.5e
T ₉ - Malt + Sugar + Papaya (1:1:1)	0.0	0.0	0.0	0.0	0.0	1.0	0.17g
T ₁₀ - Soybean + Sugar + Papaya (1:1:1)	2.0	2.0	1.0	1.5	1.5	1.5	1.58e
T ₁₁ - Peptone + Sugar + Papaya (1:1:1)	0.0	0.0	0.0	0.0	0.0	0.5	0.08g
T ₁₂ - Fruit fly diet + Sugar + Papaya (1:1:1)	1.5	2.0	2.5	3.5	5.0	6.5	3.5b
T ₁₃ - Casein + Sugar + Papaya (1:1:1)	4.5	5.5	3.5	4.0	4.5	4.0	4.33a
T ₁₄ - Protone + Sugar + Papaya (1:1:1)	0.0	0.5	2.0	0.0	0.0	1.5	0.67f
T ₁₅ - Papaya + Sugar (1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0g
T ₁₆ - Banana + Sugar (1:1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0g

Means followed by the same alphabet in a column do not differ significantly by DMRT at 5%

was attracted across all periods ranging from 1.5 to 6.5 with a mean catch of 3.5 fruit flies/trap/week.

Fruit fly diet + sugar + banana (T₅) was also found to be good in attracting female fruit flies accounting for a highest and lowest trap catch of 2.0 and 4.5 fruit flies/trap/week, respectively, across the study period. Baits containing only papaya + sugar (T₁₅) and banana + sugar (T₁₆) did not attract any fruit flies.

4.5 RELATIONSHIP BETWEEN TRAP CATCHES AND WEATHER PARAMETERS

Studies were conducted to find out the relationship between trap catches of different species of fruit flies and weather parameters such as maximum temperature, minimum temperature, total rainfall, morning and afternoon relative humidity. In order to study the instantaneous effect of these weather parameters as independent variables on population of the pest, correlation co-efficient and multiple linear regression coefficient were worked out by taking average population as dependent variable (r).

4.5.1 Relationship between trap catches and weather parameters in guava

In guava, trap catches of *B. dorsalis* had high significant positive correlation with minimum temperature ($r=0.547^{**}$) and morning ($r=0.604^{**}$) and afternoon relative humidity ($r=0.619^{**}$) and high significant negative correlation with maximum temperature ($r=-0.509^{**}$) (Table 22). When the data were subjected to regression analysis, the multiple linear regression model obtained was

$$Y = 3.61 - 2.00 x_1 + 2.29 x_2 - 4.12 x_3 - 6.74 x_4 - 1.64 x_5 \text{ (Table 23).}$$

where,

Y = Number of fruit flies trapped

x_1 = Maximum temperature (°C)

Table 22. Correlation co-efficient (r) of trap catches with weather parameters in guava orchard at Dharwad

Fruit fly species	Temperature (°C)		Total rainfall (mm)	Relative humidity (%)	
	Maximum	Minimum		Morning	Afternoon
<i>B. dorsalis</i>	-0.509**	0.547**	0.041	0.604**	0.619**
<i>B. correcta</i>	0.042	-0.220	0.028	-0.228	-0.091
<i>B. zonata</i>	0.536**	0.259	0.031	-0.193	-0.265

n=39, table 'r' value at 5% is 0.317 and at 1% is 0.408

** Significant at 5% and 1%

Table 23. Multiple linear regression co-efficients of trap catches with weather parameters in guava orchard, Dharwad

Species	Intercept (A)	Temperature (°C)		Rainfall (mm)	Relative humidity (%)		R ²
		Maximum	Minimum		Morning	Afternoon	
<i>B. dorsalis</i>	3.61	-2.00	2.29	-4.12	-6.74	-1.64	0.567*
<i>B. correcta</i>	-5.31	1.21	-1.59	1.89	-2.13	3.94	0.120 NS
<i>B. zonata</i>	-0.26	-3.94	3.05	2.53	-4.19	-2.48	0.533*

n=39, table F value at 5% is 2.506

* Significant at 5%

x_2 = Minimum temperature (°C)

x_3 = Total rainfall (mm)

x_4 = Morning relative humidity (%)

x_5 = Afternoon relative humidity (%)

All the parameters together contributed 56.7 per cent variation of trap catch.

In case of *B. correcta*, minimum temperature and morning and afternoon relative humidity had non-significant negative correlation with trap catches. Trap catch had non-significant positive correlation with maximum temperature and total rainfall (Table 22).

The multiple linear regression model fitted was

$$Y = -5.31 + 1.21 x_1 - 1.59 x_2 + 1.89 x_3 - 2.13 x_4 + 3.94 x_5.$$

All the weather parameters together contributed only 12.0 per cent variation of trap catch (Table 23).

Maximum temperature had a high positive significant correlation with trap catches of *B. zonata* ($r=0.536^{**}$). Minimum temperature and rainfall had non-significant positive correlation, while, morning and afternoon relative humidity showed a non-significant negative correlation with trap catches (Table 22). The regression equation fitted was

$$Y = -0.26 - 3.94 x_1 + 3.05 x_2 + 2.53 x_3 - 4.19 x_4 - 2.48 x_5.$$

Total influence of weather parameters on trap catch was 53.3 per cent (Table 23).

4.5.2 Relationship between trap catches and weather parameters in mango

There was high significant positive correlation between trap catches of *B. dorsalis* and minimum temperature ($r=0.562^{**}$) morning relative humidity ($r=0.56^{**}$) and afternoon relative humidity ($r=0.578^{**}$), while, significant negative correlation was observed with

maximum temperature ($r = -0.37^*$). Total rainfall had positive non-significant effect on trap catches (Table 24). The regression model fitted was

$$Y = 0.3 - 7.42 x_1 + 1.47 x_2 - 2.71 x_3 - 2.74 x_4 + 1.08 x_5$$

and there was 45.6 per cent influence of weather parameters on trap catches (Table 25).

In case of *B. correcta*, the pest population was not affected by maximum temperature but had significant negative relationship with minimum temperature ($r = -0.331^*$) and non-significant negative correlation with morning and afternoon relative humidity and total rainfall (Table 24). The multiple linear regression model fitted was

$$Y = -15.84 + 1.92 x_1 - 2.81 x_2 + 1.05 x_3 - 1.86 x_4 + 5.86 x_5.$$

Overall contribution of these parameters on trap catch was 19.8 per cent (Table 25).

In case of *B. zonata*, the population had high significant positive correlation ($r = 0.552^{**}$) with maximum temperature. However, with minimum temperature and total rainfall, fruit fly population had non-significant positive correlation and negative non-significant correlation with morning and afternoon relative humidity (Table 24). The linear model fitted was

$$Y = -11.42 + 3.56 x_1 - 1.28 x_2 + 9.68 x_3 + 1.22 x_4 + 4.84 x_5.$$

Total influence of weather parameters on trap catch was 51.4 per cent (Table 25).

Table 24. Correlation co-efficient (r) of trap catches with weather parameters in mango orchard at Dharwad

Fruit fly species	Temperature (°C)		Total rainfall (mm)	Relative humidity (%)	
	Maximum	Minimum		Morning	Afternoon
<i>B. dorsalis</i>	-0.37*	0.562**	0.070	0.560**	0.578**
<i>B. correcta</i>	0.048	-0.331*	-0.057	-0.291	-0.140
<i>B. zonata</i>	0.552**	0.228	0.091	-0.043	-0.141

n=40, table 'r' value at 5% is 0.312 and at 1% is 0.403

** Significant at 5% and 1% level

* Significant at 5%

Table 25. Multiple linear regression co-efficients of trap catches with weather parameters in mango orchard at Dharwad

Species	Intercept (A)	Temperature (°C)		Rainfall (mm)	Relative humidity (%)		R ²
		Maximum	Minimum		Morning	Afternoon	
<i>B. dorsalis</i>	0.30	-7.42	1.47	-2.71	-2.74	1.08	0.456*
<i>B. correcta</i>	-15.84	1.92	-2.81	1.05	-1.86	5.86	0.198 NS
<i>B. zonata</i>	-11.42	3.56	-1.28	9.68	1.22	4.86	0.514*

n=40, table F value at 5% is 2.498

* Significant at 5%

Discussion

V. DISCUSSION

Results of various experiments conducted to evaluate the efficacy of different types of traps, to study species complex and their relative abundance, monitoring, evaluation of female targeted protein food baits and relationship between trap catches and weather parameters are discussed in this chapter.

5.1 EVALUATION OF DIFFERENT TYPES OF TRAPS IN ATTRACTING FRUIT FLIES IN GUAVA AND MANGO

5.1.1 Experiment-1: Evaluation of different types of traps in attracting fruit flies in guava and mango orchards at Dharwad

Response of *B. dorsalis* in guava and mango

Effect of different types of traps in terms of shape, size and colour varied on the catches of *B. dorsalis* during fruiting and non-fruiting periods of guava and mango.

In guava, only size of the trap had significant influence on trap catch with big trap attracting more fruit flies (0.70 fruit flies as against 0.51 fruit flies/trap/week in small trap), during fruiting period (Table 2.1). None of the other parameters either alone or together had influence on trap catches during fruiting and non-fruiting periods. When the data were pooled, medium and big traps (0.35 and 0.39 fruit flies) attracted more fruit flies (Table 2.3). When size, shape and colour of the traps were considered together, response of *B. dorsalis* was quite wide-spread with several traps attracting statistically equal number of fruit flies (Table 2).

In mango, size and shape of the trap alone had influence on trap catch with medium and big traps capturing more fruit flies during fruiting (0.13 and 0.09 fruit flies) and non-fruiting periods (0.47 fruit flies) and also when the data were pooled (0.29 to 0.32

fruit flies) (Table 5.1, 5.2 and 5.3). Similarly spheres captured more fruit flies (0.13 to 0.56 fruit flies/trap/day). Colour alone had influence only during non-fruiting period and when the data were pooled, with orange and green coloured traps attracting more fruit flies (0.30 to 0.51 fruit flies). When all the three parameters (size, shape and colour) were considered together, medium orange cylinder (CO2) (0.25 fruit flies) and big orange sphere (SO3) (0.29 fruit flies) during fruiting period (Table 5) and big green sphere (SG3) (0.77 fruit flies) during non-fruiting period were found to be more attractive. Pooled data from both periods revealed green medium (SG2) and big spheres (SG3) and all orange spheres (SO1, SO2, SO3) as efficient traps attracting 0.47 to 0.49 fruit flies.

Present results endorse the findings of Vargas *et al.* (1991), Stark and Vargas, (1992), Jalaluddin *et al.* (1998), Cornelius *et al.* (1999), Madhura (2001), Sarada *et al.* (2001a) who also observed that *B. dorsalis* showed greater preference towards orange, yellow and white (transparent) colour. However, among shape and size, higher catches of *B. dorsalis* was reported in 4-cm diameter spheres (Vargas *et al.*, 1991), plastic bucket traps (Stark and Vargas, 1992), 250 ml cylinders (Jalaluddin *et al.*, 1998) spheres and Ladd traps (Cornelius *et al.*, 1999; Alyokhin *et al.*, 2000) and open pan traps (Sarada *et al.*, 2001a). Cornelius *et al.* (1999) also reported that captures of *B. dorsalis* increased with increase in sphere size.

Response of *B. correcta* in guava and mango

Size, shape and colour of the traps greatly influenced the trap catches both in guava and mango.

In guava, medium and big traps during fruiting period and big traps during non-fruiting period, attracted more fruit flies (7.30, 7.61 and 5.39 fruit flies/trap/day, respectively) (Tables 3.1 and 3.2). Spheres and bottles attracted more fruit flies during fruiting and non-fruiting periods (8.20 and 5.62 fruit flies /trap/day), respectively. Among

the colours, green during fruiting and transparent and orange during non-fruiting periods were efficient (7.54, 5.47 and 5.39 fruit flies/trap/day). When the data were pooled, big size traps and spheres were efficient (6.50 and 6.65 fruit flies) while effect of colour was not apparent (Table 3.3). All the three parameters when considered together, big red sphere (SR3) and medium green cylinder (CG2) attracted significantly more fruit flies (10.13 and 9.76 fruit flies, respectively) (Table 3).

In mango, big trap during fruiting (6.24 fruit flies) and medium trap during non-fruiting period (8.12 fruit flies) were efficient (Tables 6.1 and 6.2). Spheres captured more fruit flies during both periods (6.02 and 8.50 fruit flies). Among colours, transparent and orange traps performed better during fruiting (6.19 fruit flies) and non-fruiting (7.95 fruit flies) periods, respectively. All the parameters together had significant influence with more captures in green big sphere (SG3) (9.50 fruit flies) and big orange sphere (SO3) (8.75 fruit flies) during fruiting season while orange medium bottle (BO2) (11.52 fruit flies), transparent medium bottle (BT2) (11.89 fruit flies) and transparent medium sphere (ST2) (11.84 fruit flies) capturing higher fruit flies during non-fruiting period. When the data were pooled, big green spheres (SG3) and big orange bottle (BO3) attracted more fruit flies (10.02 and 9.39 fruit flies/trap/day) (Table 6).

Present results clearly show that *B. correcta* is attracted to big green spheres and big orange bottle. Similar results are also reported by Jalaluddin *et al.* (1998), Sarada *et al.* (2001a). Greany *et al.* (1977) and Sivinski (1990) also reported that bigger orange rectangles and spheres were preferred by *A. suspensa*. Similarly preference of big green, yellow and orange spheres by *A. ludens* is also reported by Robacker *et al.* (1990) and Robacker (1992). However, *C. capitata* preferred the trap with green and yellow band (Heath *et al.*, 1995).

Response of *B. zonata* in guava and mango

In guava, *B. zonata* did not respond to size, shape and colour of the trap when considered alone during fruiting period (Table 4.1). However, all the parameters together showed very less influence with most of the traps attracting statistically equal number of *B. zonata* (Table 4). During non-fruiting period, only shape and colour alone had significant influence with bottles attracting more fruit flies (0.58/trap/day) while transparent, red and orange colours were more preferred (0.38 to 0.47 fruit flies) (Table 4.2). All the parameters together also had influence on trap catch with big transparent (BT3) (1.44 fruit flies), red medium (BR2) (1.41 fruit flies) and big orange bottle (BO3) (0.90 fruit flies) attracting more fruit flies (Table 4). When the data were pooled, big transparent and medium red bottle (BT3 and BR2) were efficient with trap catches of 0.99 and 0.88 fruit flies/trap/day, respectively (Table 4).

In mango, size, shape and colour when considered together, showed that medium and big transparent bottle (BT2 and BT3) (1.13 fruit flies) were efficient during fruiting period (Table 7), while in non-fruiting period, the response of *B. zonata* was widespread (Table 7). However, when the data were pooled, response of *B. zonata* was apparent with higher catches in medium transparent bottle (BT2) (0.81 fruit flies/trap/day) (Table 7).

Variation in the response of *B. dorsalis* and *B. zonata* in fruiting and non-fruiting periods both in guava and mango was obviously due to differential population prevailing during these periods. When the population was low, response of both the species was quite widespread without showing strong response to any particular size or shape or colour of the trap.

Present results are in conformity with the reports of Sarada *et al.* (2001a) who reported that white and yellow traps were more preferred by *B. zonata*. Red and green spheres were also preferred by *R. pomonella* (Prokopy, 1968, 1973, 1977), *R. mendax* (Liburd *et al.*, 1998) and *Anastrepha* spp. (Bressan *et al.*, 1991).

Present results also endorse the findings of earlier studies which have showed that response of fruit flies to visual stimuli were dependent on colour, shape and size of the stimulus (Prokopy, 1968, Economopoulos, 1989, Katsoyannos, 1989).

Spheres constitute a super-normal fruit type visual stimulus for the fruit flies (Nakagawa *et al.* 1978, Cornelius *et al.*, 1999, Mayer *et al.*, 2000). Spherical traps are more attractive per unit area and they have got a 3-dimensional shape that is visible from all directions to the fruit flies (Liburd *et al.*, 2000) which make them more efficient traps.

Present findings also clearly showed that spheres being more attractive to fruit flies. Such a preference to spheres is also exhibited by many species of fruit flies like, *B. oleae* (Katsoyannos and Kouloussis, 2001), *Anastrepha* spp. (Bressan *et al.*, 1991), *C. capitata* (Nakagawa *et al.*, 1978, Katsoyannos and Papadopoulos, 2004), *A. fraterculus* (Cytrynowicz *et al.*, 1982), *A. suspensa* (Sivinski, 1990), *A. ludens* (Robacker, 1992), *R. indifferens* (Mayer *et al.*, 2000) and *R. mendax* (Liburd *et al.*, 1998, 2000).

5.1.2 Experiment-2: Evaluation of different coloured methyl eugenol traps in attracting fruit flies in guava orchard at Hosaritti

At Hosaritti, both *B. dorsalis* and *B. correcta* clearly showed significant preference to orange traps (Fig.1). Higher catches of *B. dorsalis* (71.4 and 17.0) were recorded during 1st and 3rd month (Table 8), while that of *B. correcta* were observed during 1st (29.8 fruit flies), 2nd (133.60 fruit flies) and 3rd (299.4 fruit flies) months of observation (Table 9). Transparent and red colours were the next preferred colours.

Fruit flies respond to colours that are similar to oviposition sites such as green, yellow and orange fruits (Vargas *et al.*, 1991 and Cornelius *et al.*, 1999). High total reflectance of yellow, white and orange colours might also be a factor in the

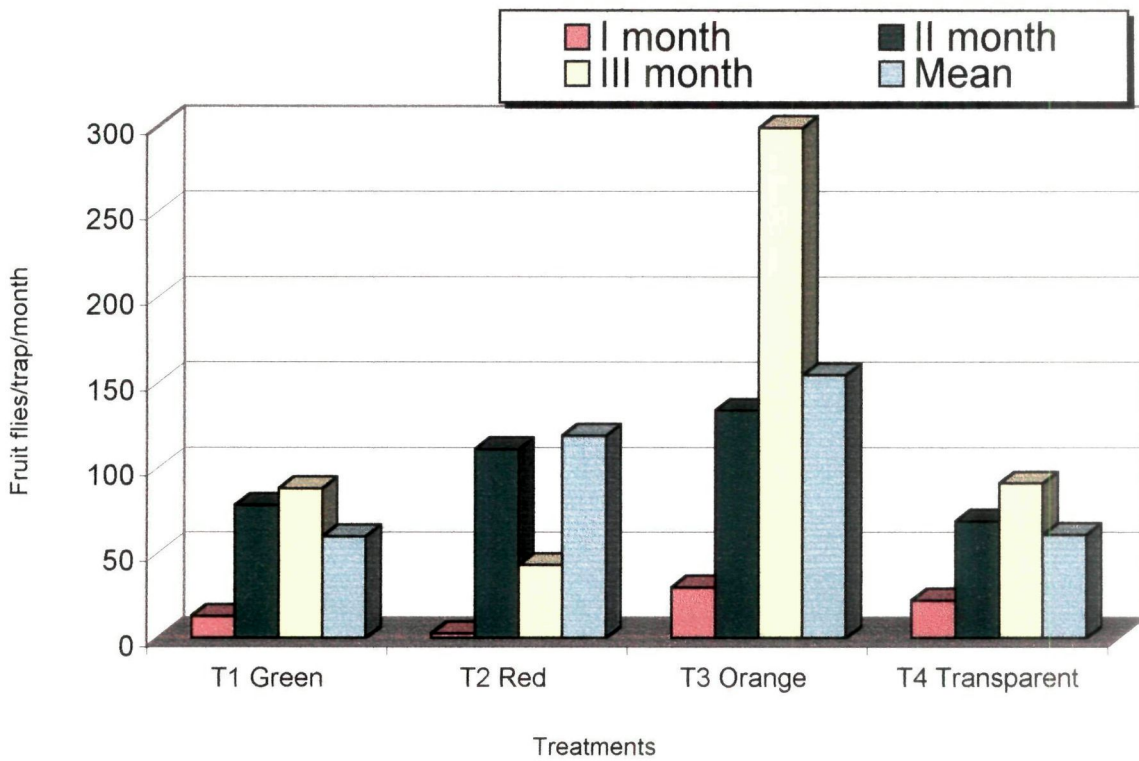
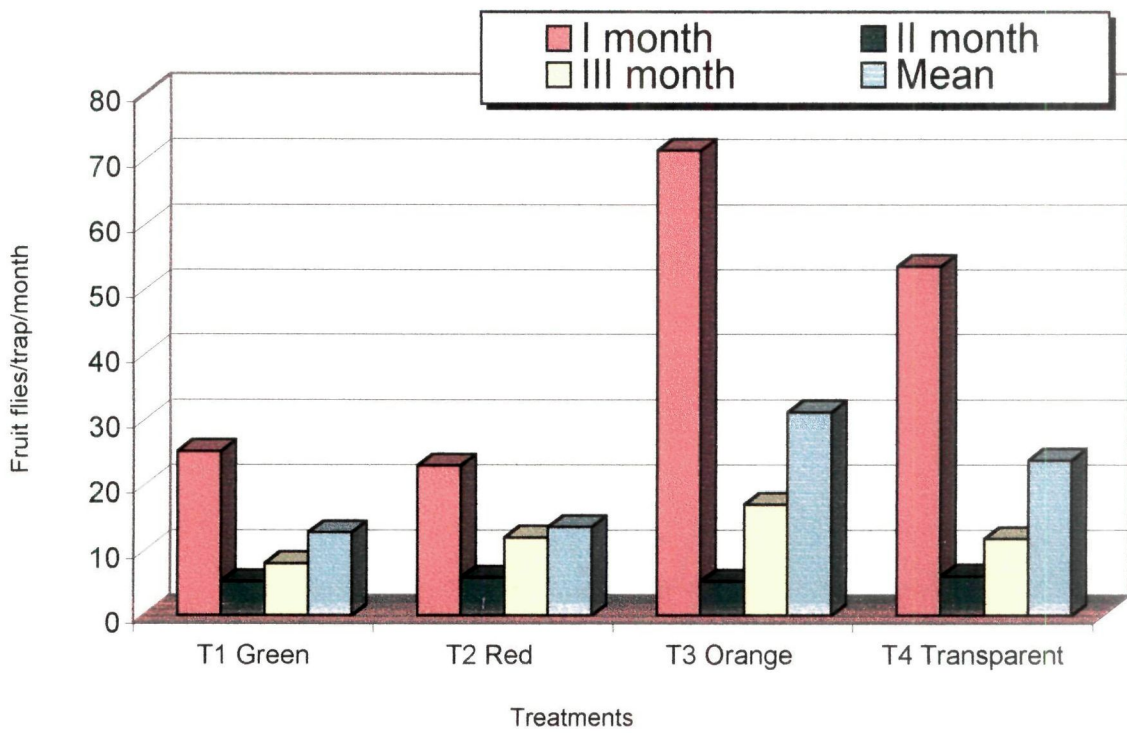


Fig. 1. Evaluation of different coloured methyl eugenol traps in attracting *B. dorsalis* and *B. correcta* in guava orchard at Hosaritti

attractiveness of fruit flies to these colours (Robacker *et al.*, 1990, Stark and Vargas, 1992). Present results endorse these reports.

5.1.3 Experiment-3: Evaluation of commercial traps in attracting fruit flies in mixed orchard at Navalur

Commercial trap Fligh-T™ captured significantly more *C. cucurbitae* with a mean capture of 12.50 fruit flies/trap/week as against 5.47 fruit flies in modified Steiner trap (Table 10). However efficiency of both traps in capturing *B. dorsalis* was not significantly different with mean catches of 4.14 and 2.58 fruit flies, respectively (Table 11). The Del-Ta trap did not attract any fruit fly throughout the study period.

Higher efficiency of Fligh-T™ trap was attributed to the structure of the trap. It consisted of two halves with yellow colour basal half and a removable transparent upper dome. Combination of these two colours might have attracted more *B. cucurbitae*. A similar type of trap was also found to attract more *A. suspensa* and *A. ludens* (Thomas *et al.*, 2001). Yellow colour is also preferred by *A. suspensa* (Greany *et al.*, 1977) and *A. ludens* (Robacker, 1992). However, *B. dorsalis* equally preferred Fligh-T™ and modified Steiner trap. Del-Ta trap though yellow externally, failed to attract both the species which was attributed to the absence of lure in this trap.

5.2 SPECIES COMPLEX AND RELATIVE ABUNDANCE OF DIFFERENT SPECIES OF FRUIT FLIES IN GUAVA AND MANGO

5.2.1 Species complex and relative abundance of different species of fruit flies in methyl eugenol traps in guava orchards at Dharwad and Hosaritti

In the present study three species of the genus *Bactrocera* viz., *B. dorsalis*, *B. correcta* and *B. zonata* were recorded from methyl eugenol traps at UAS, Dharwad.

Among the three species, *B. correcta* was predominant in the trap catches in guava orchard forming 88.93 per cent of the total population. *B. dorsalis* was the next dominant fruit fly with 6.34 percentage of catches (Fig. 2).

The species composition of fruit flies recorded from Hosaritti included *B. dorsalis*, *B. correcta* and *B. zonata* from methyl eugenol traps and *B. caryeae* from infested and caged fruits. Here also *B. correcta* was dominant constituting 78.04 per cent of the total catches followed by *B. dorsalis* (19.49%) (Fig. 2).

B. zonata was found relatively in few numbers constituting 4.73 and 2.47 per cent of the total population respectively at UAS Dharwad and Hosaritti.

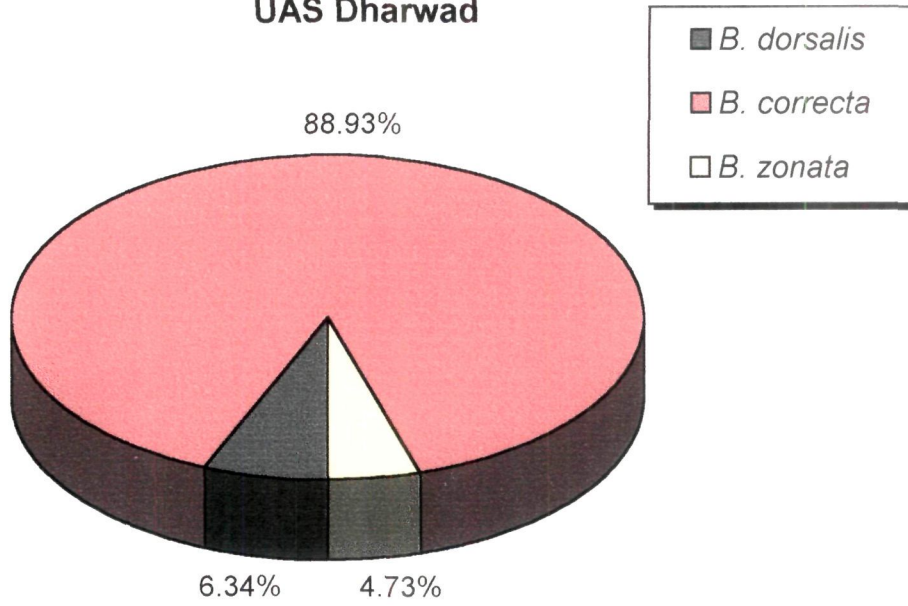
These species were also recorded from Karnataka in methyl eugenol traps by Bhat (1989), Suresh Babu (2002); Jalaluddin *et al.* (1999, 2001) from Tamil Nadu; Gupta and Bhatia (2000) from Himachal Pradesh and Sarada *et al.* (2001b) from Tirupati.

5.2.2 Species complex and relative abundance of different species of fruit flies in methyl eugenol traps in mango orchard at Dharwad

In mango also, the species composition of fruit flies included three species viz., *B. dorsalis*, *B. correcta* and *B. zonata* from methyl eugenol traps. Among these *B. correcta* had highest per cent relative abundance of 89.29, followed by *B. dorsalis* (5.49%) and *B. zonata* (5.22%) (Fig. 3).

Species composition of fruit flies was similar to the reports of Bhat (1989) from South Karnataka; Kapoor (1993) from north India; Verghese and Sudha Devi (1998) from Bangalore; Sarada *et al.* (2001b) from Tirupati, Madhura (2001) from Bangalore; Suresh Babu and Viraktamath (2003) from Dharwad; Sushilkumar *et al.* (2002) from Gujarat; and Dwivedi *et al.* (2003) from Uttar Pradesh. However, Suresh Babu and Viraktamath (2003) reported *B. dorsalis* as the dominant species from Dharwad.

UAS Dharwad



Hosaritti

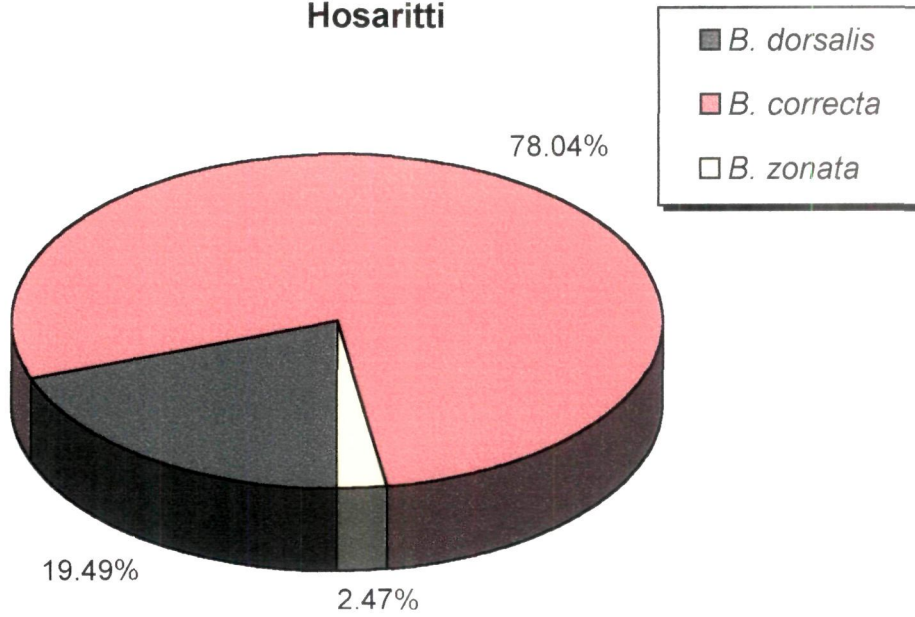


Fig.2. Species complex and relative abundance of different species of fruit flies in methyl eugenol traps in guava orchards at Dharwad and Hosaritti

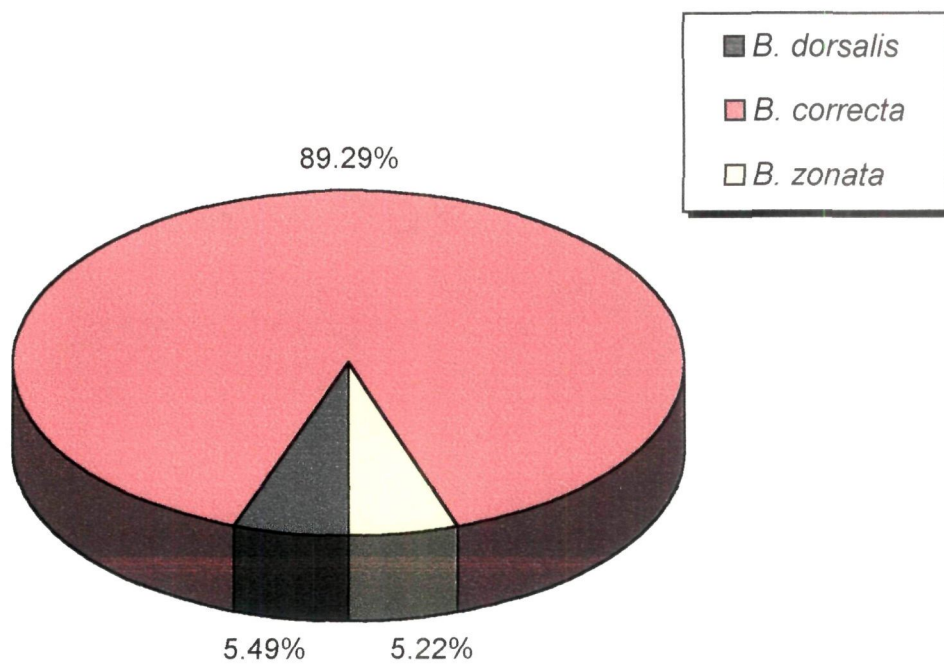


Fig.3. Species complex and relative abundance of different species of fruit flies in methyl eugenol traps in mango orchard at Dharwad

5.2.3 Species complex and relative abundance of different species of fruit flies in methyl eugenol and cuelure traps in mixed orchard at Navalur

In the present study, three species of fruit flies were trapped in methyl eugenol traps namely *B. dorsalis*, *B. correcta* and *B. zonata*. *B. correcta* was dominant forming 87.30 per cent of total catches followed by *B. dorsalis* (10.53%). *B. zonata* was the least dominant with per cent relative abundance of 2.17 (Fig. 4).

B. cucurbitae, *B. dorsalis* and *Dacus* sp. responded to cue lure traps with per cent abundance of 70.34, 29.11 and 0.55 respectively (Fig. 4). Though *B. dorsalis* is attracted to methyl eugenol lure (Ramani, 1997), interestingly this species was attracted to cuelure in the present study as also reported by Madhura (2001).

B. cucurbitae has been reported from cucurbits by Ramani (1997); Suresh Babu and Viraktamath (2003) and Ingoley *et al.* (2002). Cue-lure trap was more efficient in trapping *B. cucurbitae* as reported by Madhura (2001) and Ingoley *et al.* (2002).

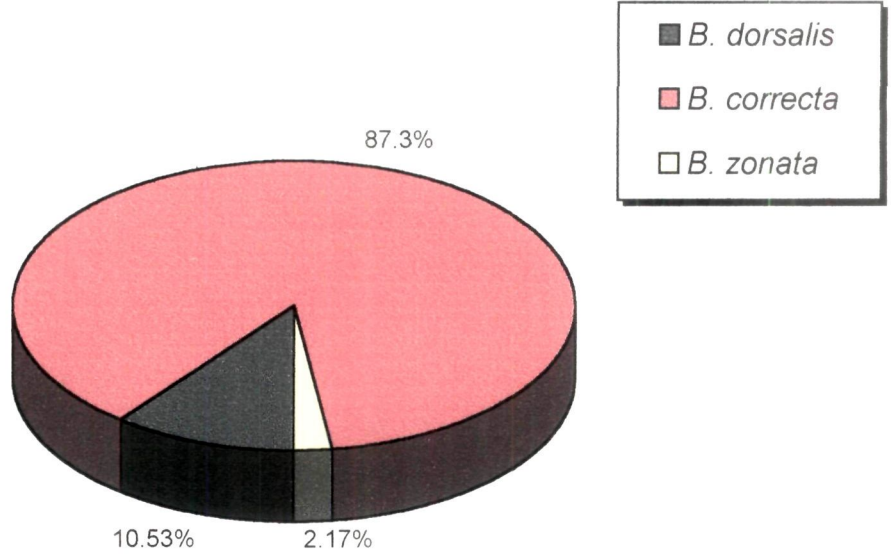
5.3 MONITORING OF DIFFERENT SPECIES OF FRUIT FLIES IN GUAVA AND MANGO

5.3.1 Monitoring of different species of fruit flies through methyl eugenol traps in guava orchards at Dharwad and Hosaritti

In guava orchard at UAS, Dharwad, higher population of *B. dorsalis* was observed from July 2nd week (27th standard week) with 12.32 fruit flies per trap and the trend was maintained upto August with a peak population of 27.16 fruit flies per trap during 30th standard week in 2003 (Fig. 5). Thereafter the population declined and remained at low level throughout 2003 and 2004. Higher population of *B. dorsalis* coincided with ripening of guava.

At Hosaritti, the peak population of *B. dorsalis* was observed during 34th standard week with 20.3 fruit flies/trap/week. The population started declining to lowest catch of

Methyl eugenol



Cuelure

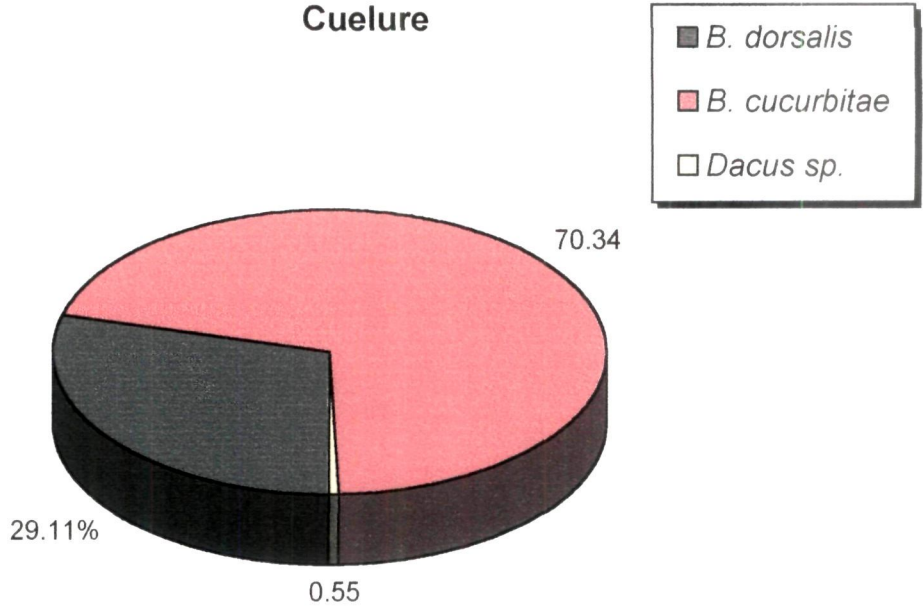


Fig. 4. Species complex and relative abundance of different species of fruit flies in methyl eugenol and cue lure traps in mixed orchard at Navalur

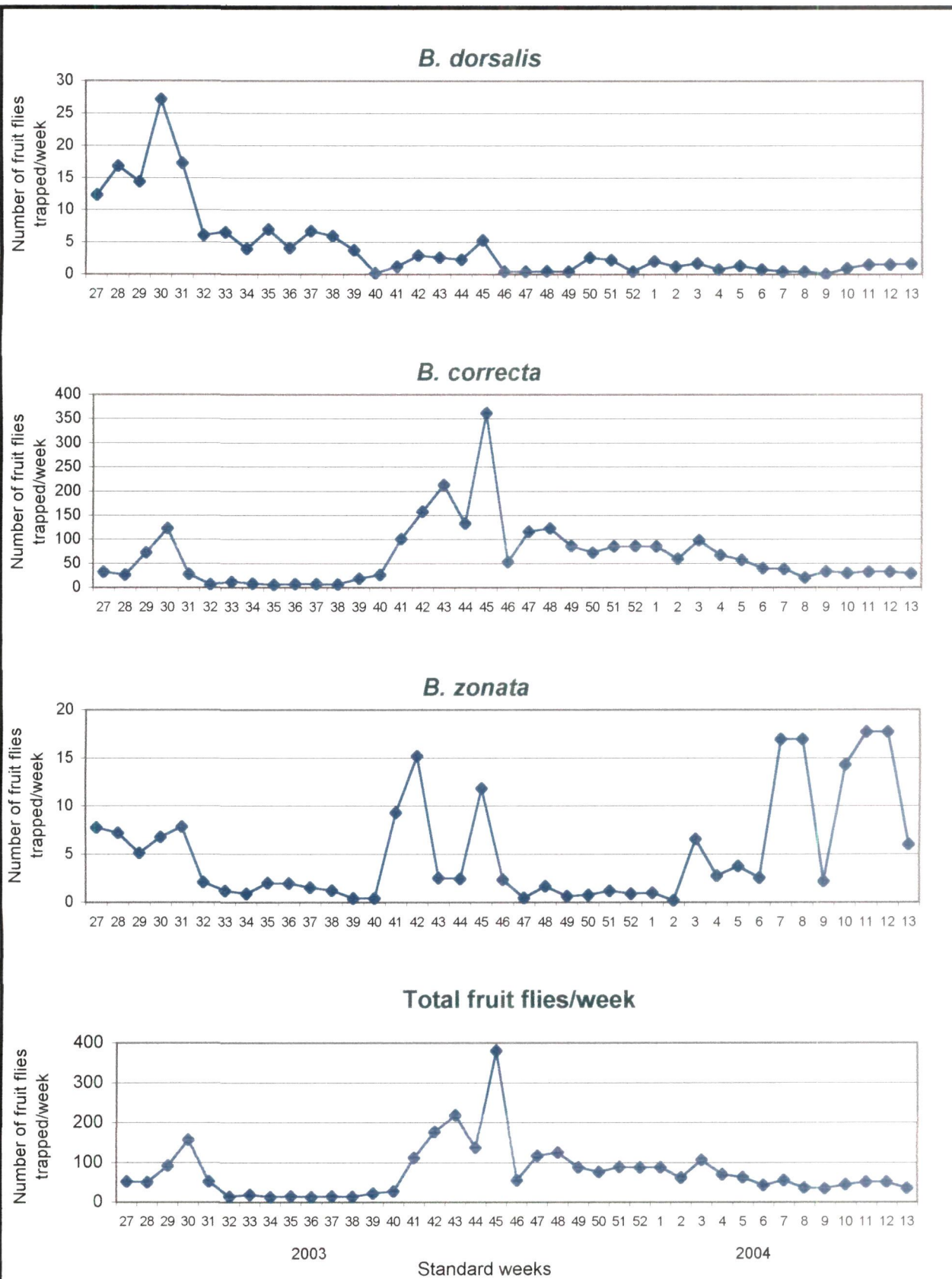


Fig. 5. Monitoring of different species of fruit flies through methyl eugenol traps in guava orchard at Dharwad

1.25 fruit flies/trap/week during 41st standard week (Fig. 6). There appears to be interspecies competition among different species of fruit flies and low catches of *B. dorsalis* might be due to dominance of *B. correcta* in the same orchard. These results endorse the findings of Agarwal *et al.* (1999) who reported suppression of *B. dorsalis* by *B. zonata* in Bihar.

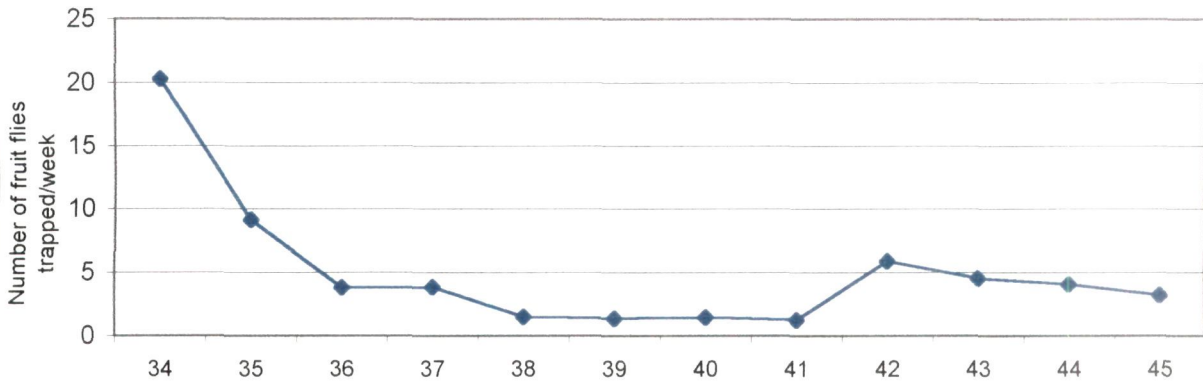
Present results are in line with the reports of Jalaluddin *et al.* (1999) who observed three peaks of fruit fly species complex (*B. zonata*, *B. correcta* and *B. dorsalis*) in Tamil Nadu. The first peak was observed during 2nd fortnight of June (470.00 fruit flies/trap), second peak during 2nd fortnight of July (416.0 fruit flies/trap) and third peak during 2nd fortnight of August (615.0 fruit flies/trap). Similar findings are also reported by Chaudhry and Jamal (2000) who observed peak activity of *B. dorsalis* from August to October coinciding with maturity of guava.

In case of *B. correcta*, a similar trend as seen in *B. dorsalis* was noticed. At first, the population reached a small peak of 123.69 fruit flies during 30th week. Thereafter highest population was observed during 45th standard week (362.67 fruit flies/trap/week) in 2003 (Fig. 5). Then the population started declining from first week of December 2003 upto 4th week of March reaching to a lowest level of 20.44 fruit flies/trap/week during 8th standard week in 2004.

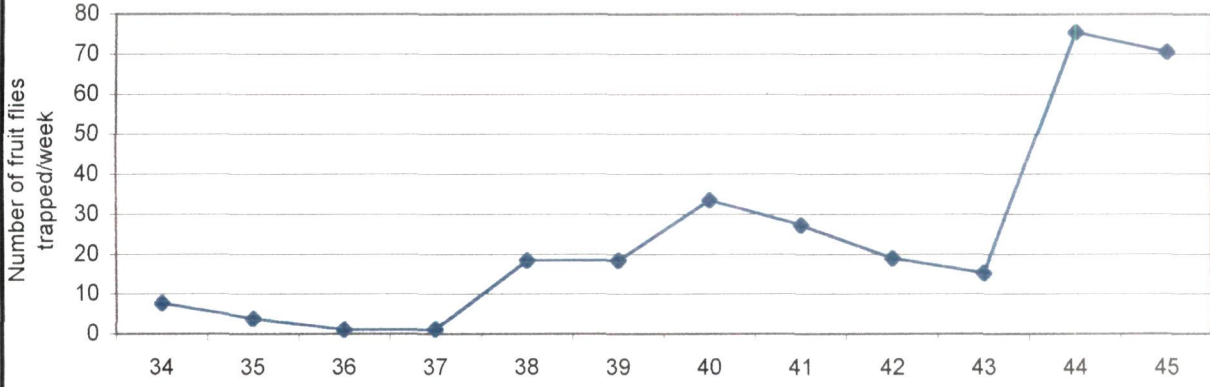
At Hosaritti also, same trend was noticed with peak population of *B. correcta* during 44th standard week (75.50 fruit flies/trap/week) and 45th standard week (70.50 fruit flies/trap/week) coinciding with maturity of fruits. *B. correcta* appears to be very dominant species replacing *B. dorsalis* and *B. zonata* in the same orchard (Fig. 6).

These observations are in conformity with the findings of Sarada *et al.* (2001b) who obtained highest and lowest fruit fly population during November, 1999 and March

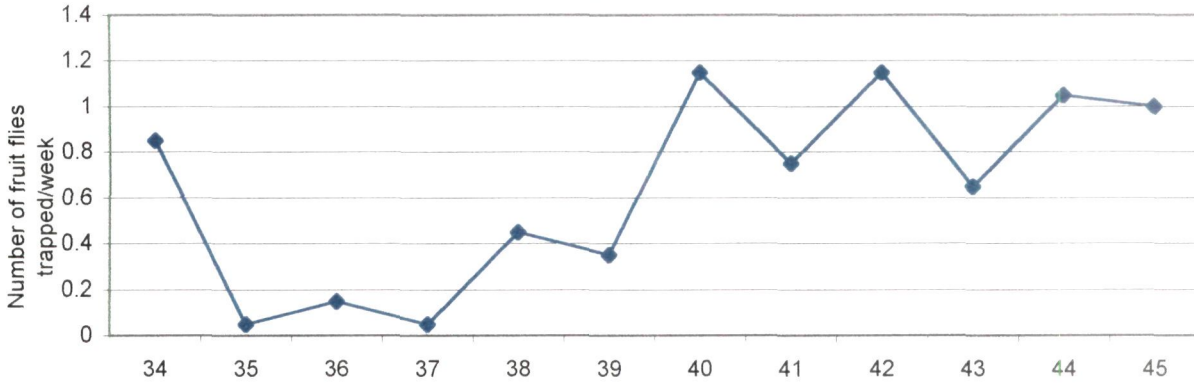
B. dorsalis



B. correcta



B. zonata



Standard weeks

Fig. 6. Monitoring of different species of fruit flies through methyl eugenol traps in guava orchard at Hosaritti

2000 respectively. Similarly Suresh Babu (2002) reported highest population of *B. correcta* during 46th standard week in 2001.

Population of *B. zonata* was recorded throughout the year with a peak population of 15.19 fruit flies/trap/week during 42nd standard week in 2003. In 2004, relatively more number of fruit flies was recorded during 7th, 8th, 11th and 12th standard weeks (16.94 to 17.71 fruit flies/trap/week) (Fig. 5).

At Hosaritti, population of *B. zonata* was quite low with maximum catches during 40th and 42nd standard weeks (1.15 fruit flies/trap/week) coinciding with fruit maturity (Fig.6).

When the total number of fruit flies irrespective of species was considered, the highest peak catch was observed during 45th standard week (379.82 fruit flies/trap/week) at UAS, Dharwad in guava orchard (Fig. 5). Similar results are also reported by Suresh Babu (2002) with peak catch in total number of flies during 46th standard week (242.98 fruit flies/trap/week) at Dharwad.

5.3.2 Monitoring of different species of fruit flies through methyl eugenol traps in mango orchard at Dharwad

First peak population of *B. dorsalis* was observed during 30th standard week (22.47 fruit flies/trap/week) in 2003 and a small peak of 5.04 fruit flies/trap/week during 13th standard week in 2004 (Fig 7). Present results are in close agreement with the reports of Verghese and Sudha Devi (1998). Gupta and Bhatia (2000) and Madhura (2001) observed peak catches in August. Suresh Babu and Viraktamath (2003) reported peak catches of *B. dorsalis* during 21st, 23rd and 46th standard weeks and a low population from 1st to 20th standard weeks.

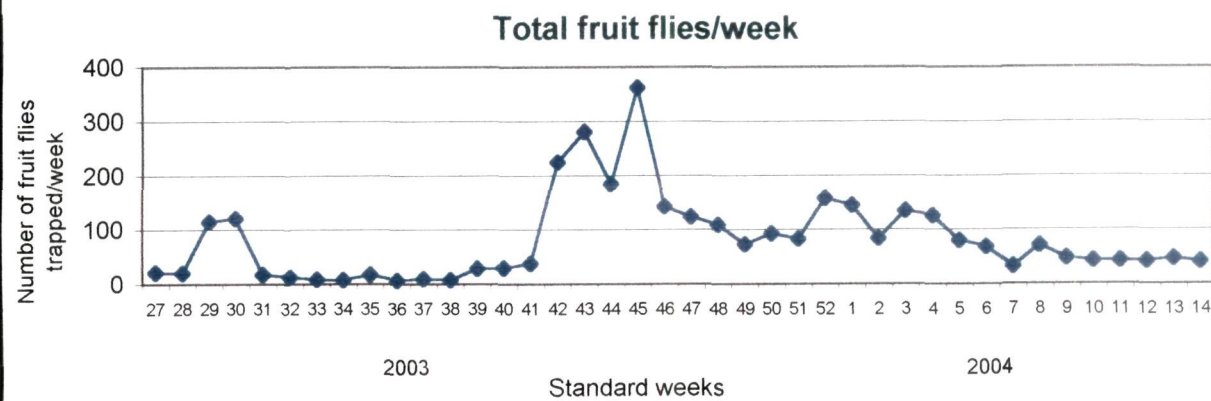
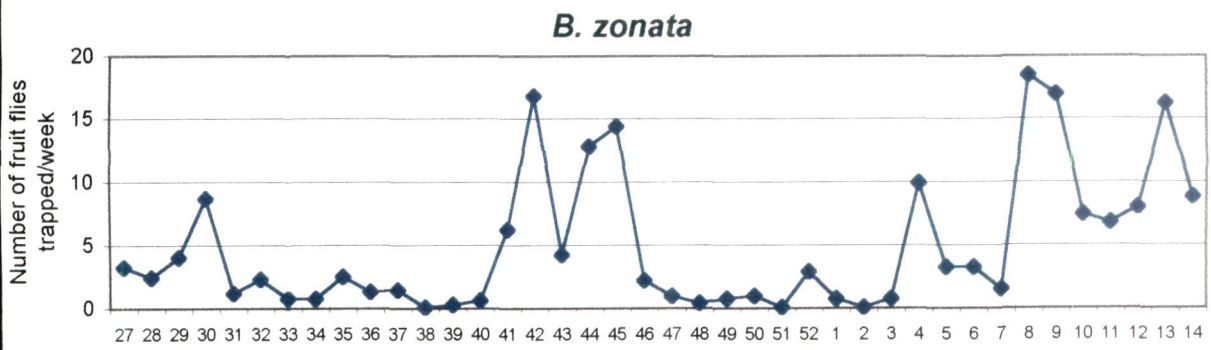
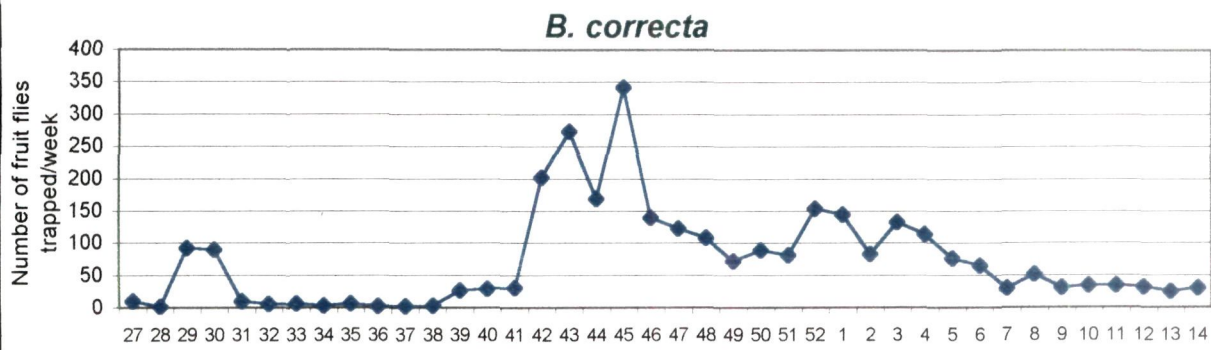
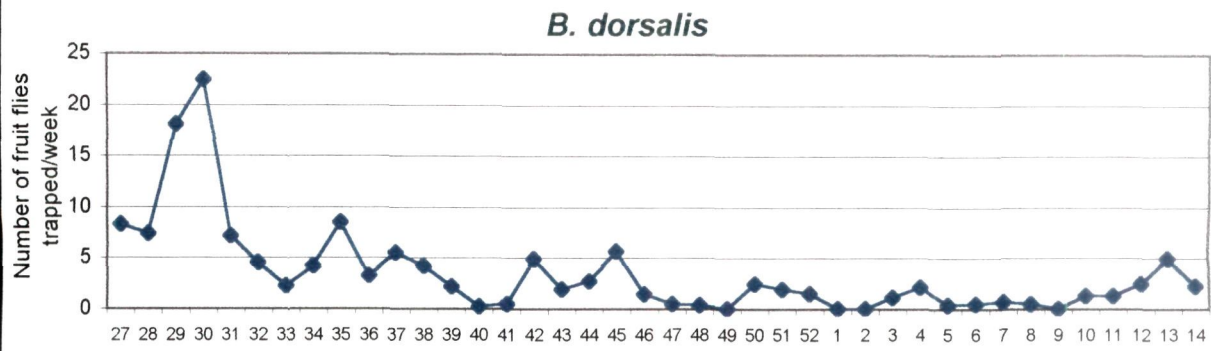


Fig. 7. Monitoring of different species of fruit flies through methyl eugenol traps in mango orchard at Dharwad

In case of *B. correcta*, peak catches occurred during 29th (92.82 fruit flies), 45th (341.53) and 52nd (153.93 fruit flies) standard weeks during 2003. In 2004, peak catches were observed during 1st (144.48 fruit flies) and 3rd (133.42 fruit flies) standard weeks (Fig. 7). Peak (92.82 fruit flies) observed during 29th week (August, 2003) coincided with the maturity of guava fruits in the adjacent garden while the peaks observed during 52nd, 1st and 3rd standard weeks was due to fruiting of mango trees in the orchard.

Present results corroborate the findings of Kumar *et al.* (1997) from Gujarat. Similarly Suresh Babu and Viraktamath (2003) reported peak activity of *B. correcta* during 21st and 47th standard week during 2001 at Kumbapur orchard, Dharwad.

Activity of *B. zonata* showed six peaks during 30th (8.68 fruit flies), 42nd (16.80 fruit flies), 45th (14.42 fruit flies), 4th (9.94 fruit flies), 8th (18.48 fruit flies) and 13th (16.24 fruit flies) standard weeks (Fig. 7). These results are in conformity with the reports of Anjum *et al.* (2000) and Gupta and Bhatia (2000) who also obtained a maximum catch of 62.6 fruit flies/trap during 27th standard week. However, Suresh Babu and Viraktamath (2003) reported peak catch of *B. zonata* during 21st standard week at Dharwad. This slight variation was attributed to change in the fruiting period of host plants around the experimental site.

When the total number of fruit flies was considered, four peak catches during 30th (120.89 fruit flies), 43rd (280.28 fruit flies), 45th (361.69 fruit flies) and 52nd (158.41 fruit flies) standard weeks were observed in 2003. In 2004, two smaller peaks were recorded during 3rd (135.38 fruit flies) and 8th (70.84 fruit flies) standard weeks (Fig.7). Contrary to these findings Suresh Babu and Viraktamath (2003) reported only two peaks during 22nd and 47th standard weeks of 2001.

5.4 EVALUATION OF PROTEIN FOOD BAITS IN ATTRACTING FEMALE FRUIT FLIES IN GUAVA AND MANGO AT NAVALUR

Christenson and Foote (1960) reported that fruit flies need to feed on protein food sources in order to mature sexually and also for development of eggs. This physiological requirement of fruit flies is being explored to develop efficient trapping systems which essentially contain protein food lure to target the female fruit flies (Epsky *et al.*, 1999).

In the present study, response of female fruit flies of *B. dorsalis*, *B. correcta* and *B. cucurbitae* to various protein food baits in guava and mango orchards was generally poor with low catches. However, proteins from soybean, yeast, fruit fly diet, protone and casein with banana or papaya pulp as base, showed clear indications of attracting significantly more fruit flies (Tables 18, 19, 20 and 21).

Protein as an important component in food bait or commercial lures to attract females of many fruit fly species has been previously documented with *B. cucurbitae* (Narayanan and Batra, 1960; Vijaysegaran, 1985; Wakabayashi and Cunningham, 1991; Steiner, 1952; Liu and Chang, 1995; Satpathy and Samarjit Rai, 2002; Fabre *et al.*, 2003), *B. dorsalis* (Steiner, 1952; Narayanan and Batra, 1960; Liu and Chen, 1992; Alyokhin *et al.*, 2000; Cornelius *et al.*, 2000a and b), *C. capitata* (Heath *et al.*, 1995; Epsky *et al.*, 1995; Katsoyannos *et al.*, 1999; Heath *et al.*, 1997; Boscan de Martinez *et al.*, 2001; Broughton and Francis de Lima, 2002), *A. ludens* (Robacker *et al.*, 1990; Heath *et al.*, 1993), *B. frauenfeldi* (Sar *et al.*, 2001), *B. oleae* (Montiel and Jones, 2002; Ros *et al.*, 2003), *B. zonata* (Gopaul *et al.*, 2000), *C. rosa* (Gopaul *et al.*, 2000) and *R. indifferens* (Mayer *et al.*, 2000) and the present results also endorse these findings.

Maximum number of females of *B. dorsalis*, *B. correcta* and *B. cucurbitae* trapped in protein food baits in the present study in guava was 3.0, 1.5 and 1.0 fruit flies per trap

per week, respectively (Table 18). Corresponding number of females in mango was 2.33, 0.0, 2.17 fruit flies, respectively (Tables 19 and 20). Irrespective of species, the maximum number of females attracted to protein food baits was 4.5 and 4.33 females/trap/week in guava and mango respectively. Though the level of trapping is low in the present study, considering very high fecundity of 300-1500 for these fruit flies (White and Elson-Harris, 1992), it may have significant impact in reducing the infestation.

5.5 RELATIONSHIP BETWEEN TRAP CATCHES AND WEATHER PARAMETERS

5.5.1 Relationship between trap catches and weather parameters in guava

In Guava orchard at UAS, Dharwad, trap catch of *B. dorsalis* had high significant positive correlation with minimum temperature ($r=0.547^{**}$), morning relative humidity ($r=0.604^{**}$) and afternoon relative humidity ($r=0.619^{**}$) and a high significant negative correlation with maximum temperature ($r=-0.509^{**}$) (Table 22). Weather parameters together influenced the trap catches to the extent of 56.7 per cent (Table 23).

Trap catches of *B. correcta* had no relationship with the weather parameters which together contributed to only 12 per cent variation in the trap catches (Tables 22 and 23).

However, trap catches of *B. zonata* were significantly and positively correlated with maximum temperature ($r=0.536^{**}$) and no correlation was observed with the remaining parameters (Table 22). All weather parameters together influenced the trap catches to the extent of 53.3 per cent (Table 23).

These results with respect to *B. dorsalis* corroborate the findings of Gupta and Bhatia (2000) who observed a significant positive correlation between trap catches of *B. dorsalis* and maximum and minimum temperature.

Though large number of *B. correcta* were attracted to lure traps, no correlation was observed with weather parameters in the present study. These observations are contradictory to the findings of Jalaluddin *et al.* (2001) who observed the population of *B. correcta* having a significant positive correlation with mean maximum temperature and minimum temperature.

Results with respect to *B. zonata* are in agreement with the reports of Agarwal and Kumar (1999b) and Suresh Babu (2002) who observed that *B. zonata* population had a high significant positive correlation ($r=0.62^{**}$) with maximum temperature.

5.5.2 Relationship between trap catches and weather parameters in mango

In mango, there was a high significant positive correlation between trap catches of *B. dorsalis* and minimum temperature ($r=0.562^{**}$), morning relative humidity ($r=0.56^{**}$) and afternoon relative humidity ($r=0.578^{**}$) while significant negative correlation with maximum temperature ($r=-0.37^*$) (Table 24). Influence of all weather parameters together was to the tune of 45.6 per cent (Table 25).

In case of *B. correcta*, the population was significantly negatively correlated with minimum temperature ($r=-0.331^*$) and no correlation was observed with the remaining parameters (Table 24). All weather factors together had influence on the trap catches only to the extent of 19.8 per cent (Table 25).

B. zonata population showed significant positive correlation only with maximum temperature ($r=0.552^*$) (Table 24). However, all weather parameters together influenced the trap catches to the tune of 51.4 per cent (Table 25).

Vergheese and Sudha Devi (1998) and Gupta and Bhatia (2000) also observed a positive correlation of *B. dorsalis* population with maximum temperature and minimum

temperature. Similarly, Agarwal and Kumar (1999b) also reported positive relationship between trap catches of *B. zonata* and maximum temperature.

Present results are in agreement with findings of Sarada *et al.* (2001a) who observed that fruit fly population of *Bactrocera* sp. had positive correlation with minimum temperature and rainfall, negative correlation with relative humidity and a positive non-significant correlation with maximum temperature.

The results are contradictory to the findings of Suresh Babu and Viraktamath (2003) who reported that *B. correcta* had a high significant positive correlation with minimum temperature.

Variations in the relationship between trap catches and weather parameters point out that population of fruit flies mainly depends on the availability of host crop (guava and mango) as also opined by Shekharappa *et al.* (1998), Madhura (2001) and Suresh Babu and Viraktamath (2003).

FUTURE LINE OF WORK

1. Different traps need to be evaluated under high population density of *B. dorsalis* and *B. zonata*
2. Protein food baits need to be improved to enhance their efficacy in attracting female fruit flies
3. Monitoring studies need to be continued for several years to draw meaningful inferences about population dynamics •

Summary

VI. SUMMARY

Results of the investigations carried out at Dharwad, Hosaritti, and Navalur from July 2003 to April 2004 on evaluating the efficacy of different types of traps, species complex and their relative abundance, monitoring, evaluation of female targeted protein food baits and relationship between trap catches and weather parameters of fruit flies are summarized below.

A total of 36 traps which differed in size, shape and colour were evaluated for their efficacy in attracting fruit flies in guava and mango during fruiting and non-fruiting periods. Pooled data from both the periods showed that medium transparent bottle in guava, and small, medium and big orange spheres and medium green sphere in mango, were efficient against *B. dorsalis*. Medium green cylinder and big red sphere in guava and big orange bottle and big green sphere in mango were efficient against *B. correcta*. *B. zonata* was attracted more to medium red and big transparent bottle in guava and medium transparent bottle in mango ecosystem. At Hosaritti, *B. dorsalis* and *B. correcta* preferred orange coloured bottle traps.

Among commercial traps, Fligh-T™ was found to attract significantly more *B. cucurbitae* compared to modified Steiner trap. But *B. dorsalis* was attracted to both traps equally. Del-Ta trap did not attract any fruit fly.

Totally three species of fruit flies namely, *B. dorsalis*, *B. correcta* and *B. zonata* were recorded in guava and mango orchards. In all the locations, *B. correcta* was most predominant constituting more than 80 per cent. However, in cuelure traps *B. cucurbitae* was dominant forming 70 per cent of total catches.

Monitoring studies revealed occurrence of *B. dorsalis*, *B. correcta* and *B. zonata* throughout the year. In guava, at Dharwad, peak catch of *B. dorsalis* was observed during 30th standard week (27.16 fruit flies) in 2003, and also a small peak during 1st standard

week (2.03 fruit flies) in 2004. Two peaks of *B. correcta* were observed during 30th (123.69 fruit flies) and 45th standard weeks (362.67 fruit flies) in 2003. In 2004, no significant peak was observed.

B. zonata had three major peaks during 42nd standard week (15.19 fruit flies) in 2003 and 11th and 12th standard weeks in 2004 with 17.71 fruit flies. When total number of fruit flies was considered, three peaks were observed during 30th (157.64 fruit flies), 43rd (218.75 fruit flies) and 45th (379.82 fruit flies) standard weeks in 2003. In 2004, major peak was during 3rd (107.10 fruit flies) standard week.

At Hosaritti, only one peak was observed in case of *B. dorsalis* during 34th week with 20.3 fruit flies/trap/week. *B. correcta* had two major peaks during 44th (75.50 fruit flies) and 45th week (70.50 fruit flies), while, *B. zonata* had two small peaks during 40th and 42nd weeks (1.15 fruit flies).

In mango, *B. dorsalis* had one major peak during 30th (22.47 fruit flies) week in 2003. In 2004, small peaks occurred during 4th, 12th and 13th (2.17, 2.52 and 5.04 fruit flies) standard weeks.

B. correcta had one small peak during 29th standard week (92.82 fruit flies), a major peak during 45th week (341.53 fruit flies) and another peak during 52nd week (153.93 fruit flies) in 2003. However, in 2004, peaks occurred during 1st and 3rd weeks with 144.48 and 133.42 fruit flies, respectively.

B. zonata had two peaks during 42nd (16.8 fruit flies) and 45th (14.42 fruit flies) standard weeks in 2003. In 2004, peaks occurred during 8th (18.48 fruit flies) and 13th (16.24 fruit flies) weeks.

When total fruit flies were considered, highest peak occurred during 45th standard week with 361.69 fruit flies in 2003, while in 2004, it occurred during 1st week (145.32 fruit flies).

Among various protein baits tested, yeast, soybean, fruit fly diet, protone and casein were more female selective. When total fruit flies were considered, soybean + sugar + banana was the most superior protein bait with fruit fly capture of 4.5 per trap per week in guava, while, casein + sugar + papaya attracted more female fruit flies with mean capture of 4.33 in mango.

In guava, *B. dorsalis* had high significant positive correlation with minimum temperature ($r=0.547^{**}$) and morning ($r=0.604^{**}$) and afternoon relative humidity ($r=0.619^{**}$). It had high significant negative correlation with maximum temperature ($r=-0.509^{**}$). In case of *B. correcta* none of the parameters had significant effect on trap catches. Trap catches of *B. zonata* had high positive significant correlation with maximum temperature ($r=0.536^{**}$) while other parameters had no relationship. Overall influence of weather parameters on trap catches of *B. dorsalis* and *B. zonata* were to the extend of 56.7 per cent and 53.3 per cent, respectively in guava.

In mango, there was high significant positive correlation between trap catches of *B. dorsalis* and minimum temperature ($r=0.562^{**}$), morning relative humidity ($r=0.560^{**}$) and afternoon relative humidity ($r=0.578^{**}$). In case of *B. correcta*, only minimum temperature had a significant negative relation with trap catches ($r=-0.331^*$). The trap catches of *B. zonata* had high significant positive correlation ($r=0.552^{**}$) only with maximum temperature. Overall influence of weather parameters on trap catches of *B. dorsalis* and *B. zonata* was to the extend of 45.6 per cent and 51.4 per cent, respectively in mango.

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Appendix

APPENDIX I

**Weekly meteorological data for the year 2003-04 of Main Agricultural
Research Station, University of Agricultural Sciences, Dharwad**

Standard weeks	Temperature (°C)		Total rainfall (mm)	Relative humidity (%)	
	Maximum	Minimum		Morning	Afternoon
2003					
27 July 2-8	29.24	22.07	0.00	83.29	73.29
28 July 9-15	26.88	21.19	0.65	88.43	77.29
29 July 16-22	28.06	21.56	0.00	86.57	66.29
30 July 23-29	28.20	21.21	0.00	85.14	76.43
31 Aug 30-5	25.70	20.61	0.86	90.29	82.29
32 Aug 6-12	26.11	20.86	0.14	84.86	79.14
33 Aug 13-19	26.81	20.46	0.51	86.86	83.00
34 Aug 20-26	27.34	19.29	0.57	83.86	73.43
35 Aug 27-3	27.20	19.93	1.10	81.43	77.14
36 Sep 4-10	28.67	19.71	0.33	81.71	67.86
37 Sep 11-17	28.60	21.10	1.27	86.86	71.00
38 Sep 18-24	29.60	20.41	1.90	75.71	65.14
39 Sep 25-1	31.76	19.23	1.43	69.14	48.00
40 Oct 2-8	30.67	20.66	2.36	79.00	66.57
41 Oct 9-15	30.94	18.01	0.00	66.57	63.00
42 Oct 16-22	31.71	18.67	0.00	69.71	58.71
43 Oct 23-29	29.71	18.64	0.27	69.43	63.14
44 Nov 30-5	30.84	16.31	0.00	61.71	47.3
45 Nov 6-12	30.47	14.30	0.00	69.29	45.00
46 Nov 13-19	29.73	13.97	0.00	65.71	43.71
47 Nov 20-26	30.17	13.01	0.00	56.28	38.14
48 Nov 27-3	29.94	13.37	0.00	62.00	34.57
49 Dec 4-10	30.00	14.85	0.00	53.00	40.57
50 Dec 11-17	29.46	16.82	0.00	76.00	55.75
51 Dec 18-24	29.43	14.89	0.00	61.00	48.71
52 Dec 25-31	28.46	12.03	0.00	51.00	39.00
2004					
1 Jan 1-7	30.81	13.93	0.00	65.86	42.00
2 Jan 8-14	29.61	16.46	0.00	70.86	45.57
3 Jan 15-21	30.83	16.61	0.00	75.29	37.86
4 Jan 22-28	31.49	14.87	0.00	62.57	40.14
5 Jan 29-4	32.11	17.10	0.00	56.57	41.86
6 Feb 5-11	33.00	17.09	0.00	60.86	49.57
7 Feb 12-18	35.93	17.47	0.00	75.29	44.71
8 Feb 19-25	36.54	17.74	0.00	47.57	31.14
9 Feb 26-3	35.74	18.91	0.00	55.57	32.71
10 Mar 4-10	37.06	21.21	0.00	77.43	28.00
11 Mar 11-17	36.24	21.19	0.00	77.57	45.43
12 Mar 18-24	36.16	19.79	0.65	61.43	41.00
13 Mar 25-31	37.33	20.80	0.00	65.57	37.86
14 Apr 1-7	38.66	18.71	0.00	62.14	35.00

MONITORING OF FRUIT FLIES USING DIFFERENT TYPES OF TRAPS AND LURES IN GUAVA AND MANGO

RAJITHA A.R.

2004

SHASHIDHAR VIRAKTAMATH

ABSTRACT

Investigations were carried out to evaluate the efficacy of different types of traps, species complex, their relative abundance, monitoring, female targeted protein baits and relationship between trap catches and weather parameters in guava and mango from July 2003 to April 2004.

At Dharwad, medium transparent bottle in guava and small, medium and big orange spheres and medium green sphere in mango were the efficient traps against *Bactrocera dorsalis*. *B. correcta* was attracted to medium green cylinder and big red sphere in guava and big orange bottle and big green sphere in mango while *B. zonata* to medium red and big transparent bottle in mango. At Hosaritti, *B. dorsalis* and *B. correcta* preferred orange bottle traps. Among commercial traps, Fligh – T™ attracted more *B. cucurbitae* than modified Steiner trap.

B. correcta was dominant (>80%) in methyl eugenol while *B. cucurbitae* in cuelure (70.0%) trap. At Dharwad, peak catch of *B. dorsalis* was observed during 30th standard week both in guava and mango. *B. correcta* had two peaks in guava (30th, 45th weeks) and four peaks in mango (45th, 52nd, 1st and 3rd weeks). *B. zonata* had three peaks in guava (42nd, 11th and 12th weeks), four peaks in mango (42nd, 45th, 8th and 13th weeks). When total fruit flies were considered, highest peak was observed during 45th week in guava and mango. At Hosaritti, one peak of *B. dorsalis* (34th week) and two peaks of *B. correcta* (44th and 45th weeks) were observed.

Soybean + sugar + banana (4.5 fruit flies/trap/week) and casein + sugar + papaya (4.33 fruit flies) were the best protein baits to attract female fruit flies in guava and mango, respectively.

B. dorsalis had positive correlation with minimum temperature, morning and afternoon relative humidity while *B. correcta* with minimum temperature and *B. zonata* with maximum temperature.