
Mediterranean fruit fly (*Ceratitis capitata*) attack on fruits and its control in Sindh Pakistan

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Abstract

Fruit flies belongs the genus *Bactrocea*, *Ceratitis Capitata*. Mediterranean fruit fly belongs to genera *Dacus* and group *Bactrocera*. So far 200 species of fruit flies under 71 genera, 13 tribes and 4 subfamilies are known. All these flies can be identified through a dichotomous key running in 202 couplets. Fruit flies belong to *Anastrepha* (8species), *Bactrocera* (30 species), *Ceratitis* (7species), *Dirioxa* (2 species and *Toxotrypana* (one specie). All *Dacus* species attack on mango placed under genus *Bactrocera*..

The order of important of fruit flies are as under:

- *Dacus Ferruginus* Flo
- *Dacus Zonatus* Sound.
- *Dacus diversus* coq.

Although *Dacus Cucurbitae* coq also present in Sindh but it is less important.

The tephritidae family of Dipterous is insects like fruit fly .Lower Sindh has *decus Zonalus*, Saunders fly. The upper Sindh and the Northern Pakistan have this and another fly *Docus Dorsalis* Henpd.

Fruit fly damage is different rate, and action on different mangoes varieties. In Dashchasri it cause 3.6 to 10% damage while in Bagun phali it causes more than 80% damage. It major hosts are: Avocado, apple, banana, guava, grapefruit, lemon, peaches and mangoes (E.S.C.Smith, 1986) mulberry, orange, , fig, vegetable , gourds namely marrow, sponge gourd, bitter guard ,musk melon, plum, loquat, melon and tomatoes

General

Of 128 species of fruit fly identified 98 species found in India and Pakistan are:

- *Bactrocera* (*Bactrocera dorsalis* (Hendal) it is also called Oriental fruit fly.
- *B*(*Bactrocera*) *Zonata* fly (Saunders)
- *B*.(*Hemigymnocus*) *Diversa* (Coquillett)
- *B*.*Hageni* (de Meje)
- *B*.(*Zeugodacus*) *cucurbitae* (Coquillett)
- *B*.(*Zeugodacus*) *tau* (walker)
- *Dacus corectus* (Bezzil)
- *D*.*Incisus* (Walker)

(Kapoor.V.C.1970)

Out of 200 species, only 9 are known to cause economic losses to our fruits, vegetables, ornamental and oilseed plants. 48 species of fruit flies attack mangoes and a related species.

Dacus Ferrugineus

This fruit fly egg size is 0.1 x 0.2 mm. The full grown larva is 8.97 x 1.74mm.Pupa is about 5.57 x 2.28 mm. The female deposits 4-13 eggs in single puncture 1-2mm, below the skin of the fruit. The maggots are full grown in 5-9 days in summer and 9-20 days in autumn. The adult flies live 27-44 days. It passes through 7 generations in a year.

Dacus Zonatus

This female fruit fly lay 44-55 eggs, and eggs produce maggots in 2-4 days in summer, 8-9 days in winter. The maggot is fully grown in 7 days in summer and 13-22 days in winter. The pupa stage lasts 8 days, in summer and 20-44 days in winter. The adults live for 37-41 days . The pest remains active about 8-9 generations during this period.

Dacus diversus

In this fruit fly egg hatch in 3-5 days and maggots get full grown in 8-12 days during summer and 14-21 days in winter . The pupa stage lasts for 8 days in summer and 20-44 days in winter. The adults live 30-43 days. The life cycle is completed in 19-31 days. The pest remains active from March to September.

A *Dorsalis* does not attacks on all cultivars to the same extent (Yee.W.1987) .It is an important pest especially of deciduous fruit trees. (P.C.Hely)

The female fruit flies insert their eggs beneath the skin of mangoes and around 1200-1500 eggs are lain by *B.Dorsalis*. The egg period last 2-20 days. Larval and pupa period is 2-4 weeks. Symptoms occur when fruit fly leaves an inconspicuous oviposition site (sting) on the skin of the fruit, when laying eggs. Small white larvae emerge from the egg and consume the fruit flesh. Fruit fly can easily be controlled by commercial orchards by pre-harvest spraying

Life history

Adult female fly inserts the ovipositor deep in fruit and eggs are deposited in clusters, each cluster have 2-15 eggs. Although 150-200 eggs are laid by female in her life time of about one month (Ref.Doharey.K.L.1983). on same fruits. Indian journal of entamology 45(4): 406-413pp). The incubation period lasts for 2-3 days during March and April and 24-36 hours throughout the other summer month. The larva period from 6-29 days .The pupa is cylindrical in shape and 4-5 mm long and 2mm broad. The pupa period lasts 6-44 days ..

Biochemistry of fruit ripening

It is occurs in following sequence.

- Respiration and ethylene production.
- Peel pigmentation.
- Pulp pigmentation.
- Texture development
- Sugar production
- Organic acids formation
- Volatiles occurrence.

Manipulation of the environment to control ripening

The following are the methods used commercially (ref. A.P, Medioott and M.J.Jeger)

- Temperature
- Ethylene
- Acetylene
- Control atmosphere storage.
- Modified atmosphere storage.

- Hypobaric storage.
- Waxing.
- Irradiation.
- Chemical control.

Fruit get decayed due to presence of maggots, inside which feed on the pulp, turn into semiliquid mass and render it unfit for human consumption. (Khawaja Abdul Haq and Muhammad Akhitar and Ghulam Dastgir)

30% fruit is attacked by *Bactrocera dorsalis* in July and August in the Punjab (Syed , R.AA, Ghani, M.A and Murtaza M)

Fruit fly Control

Preharvest control includes population management (e.g. release of sterile male fruit flies) and or insecticide application during the period when fruit are susceptible. Population can be monitored by trapping.

Harvest mature green fruit. Post-harvest heat treatment are possible alternatives (Brian B.Beattie, W.Barry Mc Glasson and Neil .L.Wade.) and (V.C.Kapoor 1993).

Bactrocera (*Bactrocera*) *Zonata* (Saunders).

Methods to control fruit fly

The following are the methods used commercially.

- Cultural and Mechanical methods.
 - a) Sanitary methods.
 - b) Chemical methods.
- Biological control methods.
 - a) Traps used for catching fruit fly
 - b) Attractant.
 - c) Formula
 - d) Sex hormones
 - e) Chemosterilant.
- Chemical control methods.
- Irradiation.
- Fumigation.
- Vapour heat treatment.
- Plant production and other methods.
- Other baits.

Fruit fly control methods

Preharvest		Postharvest.				
Cultural control	Physical control	Chemical control	Biological control	Other methods	Post harvest	Other methods
Field sanitation	Bagging of fruit	Cover spray of insecticides	Hymenopterous	Sterile insects technique	Chemical dip	Sterile insects technique
Ploughing of soil.	Wire netting	Soil treatment	Parasitoids	Resistant varieties	Heat treatment	Resistant varieties
	Wild host destruction	Bait spray	Predators	Ovipositor	Irradiation	Ovipositor
		Trapping using chemical	Pathogens	Deterrents or ovipositor	Freezing.	Deterrents or ovipositor
		Attractant	Entomopathogenic	Deterring Phermones		Deterring Phermones
		Repellent	Nematodes	Insect growth regulators		Insect growth regulators
				Quarantine.		Quarantine.

1) Cultural and mechanical methods.

Plough the field 2-3 times to kill larvae by exposure to Sun and air . Fruit covered with bags also helps in controlling the infection fruit plucking before ripening also help in reducing the population, but quantity of fruit reduced.

Control

- 1) Sanitary measures.
- 2) Chemical measures.

1) Sanitary measure

All infected fruits are collected and buried 4-5 feet deep in the soil to kill maggots. Using irradiation of fruit is another safe method, though resisted by some people.

2) Chemical measure

- a) Cover spray
- b) Bait spray.

a) Cover spray

Before mango fruit start ripening some synthetic spray of Endrin, dialodrine, dipterex, diazinon and dimecron used at the rate of half pound, one and half pound, half pound, half pound.

b) **Bait spray.**

It consist of following.

Sodium fluosilicate-----100z

Or

Lead arsenate-----30z

Molasses-----2-5lb

Water-----4 gallons.

- Bait spray contains 20g active protein hydrolysate and 10g active maldison per liter of aqueous solution, and be applied as splashes or cover spray. Two spray applications should be made approximately 4 weeks and 2 weeks prior to anticipated harvest (E.S.C.Smith)

Foliage baiting using and attractant (protein hydrolysate), carrier (water) and insecticide (maldison)

3) **Biological control.**

The parasitoids of *B.Zonata* found in Pakistan include *opinus longicaudatus* (Ashm), *Dirhinus giffardi* Silv. and *Bracon* Spp. So small fruit fly population can cause economic damage reducing success of classical biological control programs. (Richard E.Liz.1997)

a) **Attractant**

- O-methyl eugenol (an eather)is called Methyl Eugenol. Is found in the leaves of tulsi and Citronella. It is a strong male lure and mostly attracts Dacine species like *dorsalis*, *Zonata*, *correcta* and *Diversa*. The three methyl eugenol isotopes like ; 3-4 dimethylhexopropyl benzene, 3,-4 dimethoxyethoxy benzene and 3, 4-dimethoxy methoxy methyl benzene are used.
- Cue-Lure:4(p-acetoxyphenyl)-2-butanone. It is good as male lure for *B.Cucurbitae*. One of its analogue, Raspberry ketone, a natural plant product, known as Willison's lure in Australia used for *B.tryoni* male ,also attact *B.Cucurbitae*.
- Trimedlure: t_butyl_4(or 5)-Chloro-2-methyul-cyelohexanae carboxylate is best male lure for Mediterranean fruit fly, *ceratitis capitata*, it occur in eight different stero-isomeric forms.

b) **Formula**

The capture flies in a trap 1% methyl eugenol plus 0.5% , malathion or 0.1% Carbaryl (Balasubramaniam, G;E.V.Abraham; S.Vijayragfhavan, T.R.Subramaniam, T.Santhanaraman and C.R.Gunasetasan.) (Ref. Lakshmann, P.L..G.B.Balasubramaniam and T.R.Subramaniam)

- 0.1% methyl eugenol plus 0.25% malathion is used for trapping of fruit fly (Ref: Bagle, B.G.and V.G.Prasad)
- Lall and Singh used palm juice/sugar/dried mangoes/ jounce/oil of citronella mix with 10% diazionon as bait for trapping *B.cucurbitae* (Ref. Lall, B.S.and B.N.Singh.)

A formulation of 85% methyl eugenol mixture with 10% sugar, 5% naled is used for trapping of *B.Zonata* and *B.Dorsalis*. Some chemicals like Min-U-Gel 400 and Thixotrape E are used as thickening agents for increasing the effectiveness of attractants in bail application.

c) Sex hormones

Sex attractant methyl eugenol to attract the male of *D.Dorsalis*.

- The traps baited with 0.1% methyl eugenol + 0.1% carbaryl provide good control.
- The effect of environmental factors on the attractiveness of methyl eugenol to adult fruit flies.(Ref. Shukla R.P and Prashad.V.G)
- The fruit flies can be controlled by hanging pheromone traps 0.1% methyl eugenol +0.1% malathion from April-June. (Ref. Abbas. S.R and Srivastava.)

10 traps are enough for a hectare of orchard. The trap at northern direction and 2-6 feet high produce maximum results.

d) Chemosterilants.

Some chemosterilants like tepa.metapa and apholate found effective

4) Traps used for catching fruit fly.

These are as under:

- Steiner type.
- G-K-Collapsible trap.
- Sticky trap.
- Mc Phail trap

5) Chemical control of fruit fly

The bait spray mixture of tartar acid 1 part, 320 parts water and 24 parts molasses, besides bait trap prepared with protein hydrolysate 100gm water 20 liters and malathion 40 ml also help to control fruit fly.

- Bait spray of 0.75 oz protein hydrolysate 0.75oz sugar and 0.25oz malathion in one gallon of water is effective (Gupta. R.L.)
- The three weekly application of malathion can provide effective control for fruit fly (Yee W) and (G.Singh)
- Dimethoate at the rate of 75ml of 400g/L spray should be applied 6,4,2,1 weeks before harvest.(Mango pest and disorders)
- Fruit fly can be controlled by solution having mercaptothion 25% at above 300g + 8Kgs sugar per 100 liters of water.
- Diptrex 8% ,SP 200grams in 100liter of water.
- Lebaycid 5% , 225g.100liter of water
- Phosdrine 24% , EC 6OZ/100 gallon water.

Effect and results of dipping fruit for fruit fly control

Table below gives the effect of various types of dips on mortality of larvae or pupa.

Insecticide	Treatment	State	Mortality.
Dimethoats	Dip 1 min.	Egg larvae	99.8%
Fenthion	Dip 1 min	Egg larvae	99.96%

Common chemicals spray for fruit fly

Any one of the following chemicals at weekly interval will be used.

- Ac-12880(American Cynamide)
- Bi 85EC (VEB chemis Kombinet)
- Dimethoate of 400g/100L
- Fenthion at 0.6% ai
- Deltamethrin 0.002% at given 83% control i.e. 2 grams ai is 5% therefore, 40 grams are needed.
- Fenvalerste at 0.1% as effective as deltamethrin.
- Malathion 75g ai + 8Kg sugar+ 100L water as bait.
- Diptrex 75ml/L

(Mango manual by M.H.Panhwar and Farzana Panhwar)

6) Irradiation

The radiation on *B.dorsalis* and *D.cucurbitae* was checked when larvae exposed to 15,25,40, and 100Krad gamma radiation from 60C° source show slow growth and movement and although 60-70% of them pupated, but no adult did emerge.

- It is found that a dose of 0.5 KGY found sufficient to sterilize both sexes.
- Quarantine treatment is mangos fruit dip in benomyl solution (500 ppm) irradiation at 600GY to 42 hours after dipping store at 20C° in 65-75%RH.
- Laboratory experiments show that irradiation at low dose (25Krad) could prevent emergence of *B.dorsalis* and *B.Cucurbitae* (Ref. Thomas P and G.W.Rahalkaro)
- 20ml malthion or 50ml of diazionon. 200gmm gur or molasses in 2 liter of water for baiting and 20 liter of water for spraying each tree. (Ref. Butani, D.K and Srivastava)
- It is found 0.3% oxydemeton methyl or 0.03% phosphamidon or 0.06% dimethoate are effective insecticide in controlling the pest. (Talgeri)

A test of ethylene dibromide (EDB) at 6.8 and 10gms/m³ at 30-32C° and treatment was most effective at 8gm/m³.

7) Fumigation

Fumigation of mangoes with ethylene dibromide at 8 or 12gm/m³ at 21.2C⁰ for 2 hours. Refrigerating fruits at 7.6C⁰ for 4 days help in reducing the infection.

- Heating 48-50C⁰ for 20 minutes, fumigation with 12gm/m³ for 2 hours at 20C⁰ then store at 7-10C⁰ for 4 days help in checking the infection (Lin T.H.Tsang.F.C.Change, C.R.Wang C.Y)
- Fumigation of mangoes with ethylene dibromide were used to control larvae of *B.dorsalis*. The lowest dosage (20g/m³) do the job without affecting the flavour of the fruit.
- The fruit fly larvae inside the pulp of mango fruit can be killed by hot water treatment of mature fruits at 50C⁰ for 2 hours in ethylene dibromide solution (Wadhi.S.R.)
- Four sprays of 0.2% carbaryl or 0.06% dimethoate. During fruit development . The first 2 sprays were given 30 days a part and last 2 after 2 weeks (Tandon P.L.,Mathur.A.C.and Krisniah K)

It is found that deltamethrin at 0.0025% gave best control followed by 0.05% fenthion, 0.1% carbaryl and 0.03% dimethoate (Shukla, R.P.and Prashad .V.G.)

- It is found that 0.03% fenithrothion is most effective insecticide against fruit fly. (Doharety. K.L. and Butani)
- The pest can be controlled by sex hormones and phosphorus containing organic or pyrethrum systemic insecticides.
- Malthion and protein hydrolysate mixture is preferred than other bait combination.
- Quarantine treatment include forcing the hot air up to 47.2C⁰ for 3.5-7 hours at 40-60 % relative humidity. Then fruits were cooled below 30 C⁰ just after treatment.

Hot water treatment at 40C⁰ for 20 minutes then immediately followed by 10 minutes at 46C⁰ gave hundred cent percent mortality of eggs and larvae (Liang C.Q.Liang F,Lin-C.Q, Yun.C.J, and Xu-W)

8) Vapour heat treatment (VHT)

In which mangoes are treated at 110-130 F⁰ (43.3-46.1C⁰) to disinfestation of fresh fruits infested with oriental fruit fly.(Ram Prakash Srivastava)

9) Plant products and other methods.

The product clensel (a liquid soap containing ammonia . This way 65.37% *D.Zonatus filies* die The use of traps baited with lure toxicant mixture (85% methyl eugenol + 10% sugar-solution + 5% naled). This become more effective (Ref. Qureshi. Z.A.and Hussain.)

10) Other baits

The most effective bait is yeast. But others are as under:

- Mollasess
- Gur
- Mango juice.
- Ethylalchol + Gur
- Fermented juice of lemon, grapes, orange, apple, banana, mango juice at 5% most effective.

- Dichlorvoas 0.5% is added above baits. Sugar 5% is added to all juice as preservative. Deltamethrin at 0.002% give 83% control if used in trap bottles.
- Microcapothian 25% WP 300g + 8Kgs+ sugar/100 liter of water.
- Tricholorform (Chlorofarm tri chloro methan) 95% at 50g + 8Kgs sugar with 100L of water Methyleuggenol bait.

(Mango manual by M.H.Panhwar and Farzana Panhwar)

Conclusion

- In subtropical area due to polyphagous nature they create problems in their control.
- Some countries have banned the use of ethylene-di-bromide, because it may leave residues in produce. Alternatively physical disinfestation treatments such as ionising energy, cold or heat treatments may provide adequate quarantine security..
- More research is needed to study epidemiology variety resistant and suitable and economic control measure with safer chemical and to control fruit fly.

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