

# Efficacy of Abiotic Factors on Population Dynamics of Fruit Fly (*Bactrocera dorsalis*) Larva and Pupa

## Abstract

The fruit fly *B. dorsalis* is a serious fruit and vegetable pest in South-East Asia. It causes 25-100% loss of horticultural crops by laying eggs under the skin of mangoes, peaches, guava, apricots and figs. Abiotic factors are ecological factors including temperature, humidity, and rainfall. These factors adversely affect the population dynamics of fruit fly larvae and pupae. Plants were randomly selected and installed with methyleugenol pheromone traps to study the population dynamics of *Bactrocera dorsalis* and correlate with abiotic factors. The fruits that had fallen were retrieved after a gap of 7-8 days. The contaminated fruit samples were exposed in the lab after a 9-10 days incubation period, and the larvae were counted. To ascertain the relationship between the larval and pupal populations of fruit flies in citrus, the one-way ANOVA technique was used. *Bactrocera dorsalis* larvae and pupae populations were the greatest at high temperatures and low humidity.

Keywords: *Bactrocera dorsalis*, Fruit fly, Abiotic factors, Pheromone traps, methyl eugenol

## Introduction

Pakistan is endowed with vast agricultural resources. In 2019, Pakistan's total cropped area was 22.1 million hectares. Of this, food crops are limited to 65.8%, cash crops to 24.4%, legumes to 6.7%, edible oilseeds to 3.3%, vegetable planted area to about 0.62, and 3.1% of the total planted area to occupy. Pakistan produces a wide variety of fruits with a total production of 9.83 tons on an area of 743.6 thousand hectares. From this production, 768,200 tons of fruit were exported to other countries. Pakistan produces a wide variety of fruits with a total production of 9.83 tons on an area of 743.6 thousand hectares. From this production, 768,200 tons of fruit were exported to other countries. Citrus is Pakistan's top crop in terms of value in international trade. Pakistan is the world's largest producer of a special kind of reticular variety (KINNOW) and oranges, with an annual harvest of 2.4 million tons. Fruits and vegetables are of great importance to humans in many diseases (Kader, 2001; Oguntibeju et al., 2013). Fruits and vegetables are rich in nutrients, minerals, vitamins and enzymes. In addition, they have high medicinal properties. Unfortunately, some pests, such as fruit flies, are considered major pests of fresh fruits and vegetables and have successfully adapted their life cycle to most cultivated fruits with unique consequences. Fruit fly (Diptera: Tephritidae) is a major pest that is causing a

decline in fruit production (Triplehorn et al., 2005; Badii et al., 2015; Aryuwandari et al., 2020). *Drosophila* is the most serious agricultural pest, exerting economic impacts on tropical and subtropical agriculture in many parts of the world and posing a growing threat to colonization of new areas (Mishra et al., 2012). The 440 species of tefritides that make up the genus *Bactrocera* are mostly found in tropical Asia, southern Pakistan, and Australia (White and Elson-Harris 1992). Host species 173 and 125 respectively of *B. dorsalis* and *B. cucurbitae* are the most significant fruit tree pests in Hawaii (Metcalf and Metcalf 1992). *B. dorsalis* is the most common and widespread species (Vargas et al. 1983, 1990). Studies show that 95% of the population thrives on common guava trees. It is a highly destructive fruit pest. *Drosophila* is the most serious pests of all tropical and subtropical horticultural crops. They damage fruits and vegetables by laying eggs under the skin where the eggs hatch in order to feed the larvae that feed on the flesh of rotting fruits and vegetables. Infected fruits and vegetables rot quickly, and inedible crops fall to the ground prematurely, greatly reducing production. It is also called Oriental fruit fly. Oriental fruit flies acquire destructive status only in subtropical habitats (John and Armitage, 1949). Under these conditions, 1200-1500 eggs can be laid per female. West Pakistan's pears, peaches, apricots, figs and other fruits show 50-80% infection. Fruit flies lay eggs inside the fruit, which hatch inside the larvae. The larvae feed on fruits and rot the pulp of fruits and vegetables. Sanitation is the most effective way to combat fruit fly infestations. To reduce populations and disrupt reproductive cycles, infected fruits and vegetables must be removed from orchards and buried in fields. The purpose of this study was to determine the correlation between variations in *B. dorsalis* populations in different seasons and biological pressures as temperature and humidity.

## Materials and Methods

### Study area (9 square)

**Square 9** is an orchard in experimental area of university of Agriculture Faisalabad, Pakistan. It is located on Jail road, near al-khidmat police markaz, Policelines, Faisalabad, Pakistan.

The purpose of this study is to estimate the population dynamics of *Drosophila* (larvae and pupae) in five (5) host plants. It was conducted from October 15, 2022 to November 1, 2022. Installation of pheromone traps in different orchards using methyleugenol as the sex-attractant chemical. The samples were collected from buckets on daily basis from mid-October to November carefully and counted the trapped population. The infested fruits were collected in plastic bags and preserve in molecular lab of entomology department for 7-8 days for pupation in the buried fruits. After the incubation period, exposed the preserved sample and remove the outer covering by using a sharp cutter. A magnify glass used to examine the larva of *Bactrocera dorsalis*. Temperature and humidity data were collected by field thermometers and hygrometers. The objective was to investigate the population dynamics of *Drosophila* (*Bactrocera dorsalis*) and to observe the effects of temperature and humidity on *Drosophila* larvae and pupae.

## Results

The lowest mean fruit fly larvae four (4) were recorded at the lowest mean temperature 19C and highest mean humidity 68%, and the highest mean temperature 34C and lowest mean humidity 28% recorded the highest mean larval populations twenty two (22) for both. Highest mean fruit fly pupal populations in various orchards recorded when the yard experienced the highest **average** temperature and **lowest average** humidity. The lowest average pupal population was observed in the same yard with the lowest average temperature and highest average humidity.

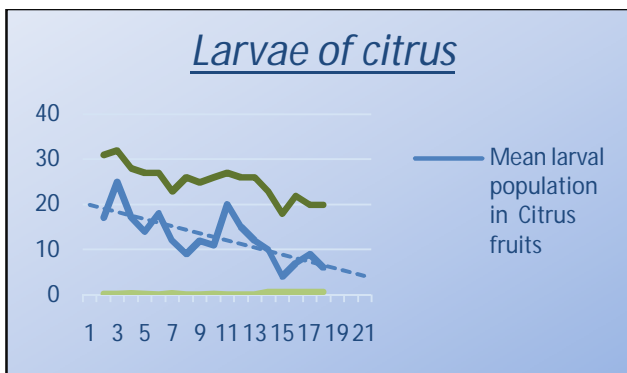


Fig.1; Comparative analysis of population of larvae of fruit files in citrus garden during study period

## Discussion

The world's largest *B. dorsalis* population is present in almost every orchard, making it challenging to grow fruits and vegetables. **In Pakistan the export of mangoes had adversely affected by the fruit flies. Due to the presence of eggs and larvae in fruits the importing country**

ban that commodity so has happened with the mango export in Pakistan. In subtropical regions of Pakistan the temperature fluctuates in regular intervals which mostly favour the fruit fly population to increase. So, this study might be helpful to manipulate the fruit fly population by understanding the correlation between fruit fly population and temperature with humidity. It has been noted that with the change in abiotic factors like temperature and humidity a fluctuation in population dynamics of *B. Dorsalis* occurs simultaneously. So, to study the relation between these factors and *B. Dorsalis* population dynamics was significant. The

number of fruit flies increased in the summer and declined in the autumn as a result of the drop in temperature and humidity. According to reports, the ideal temperature ranges between 18°C and 30°C, whereas the best temperature ranges between 15°C to 34°C for the reproduction and development of *Bactrocera dorsalis* (Vayssieres et al.,2009). When temperatures drop below the threshold temperature of 18°C, larvae and pupae continue to develop and the ratio of adults emerging from the ground decreases. Most larvae and adults die when temperatures rise above 34°C or fall below 15°C.

The population of *B. dorsalis* is seen to increase with rising temperatures, but only up to a certain point. It demonstrates a positive association between the number of fruit flies and the highest temperature. While observing humidity (%), it was found that during low humidity, egg population and development were high. Fruit flies were shown to be significantly correlated with temperature and rainy days.

Table 1 : statistical results

	<b>Coefficients</b>	<b>Standard Error</b>	<b>t Stat</b>	<b>P-value</b>	<b>Lower 95%</b>	<b>Upper 95%</b>	<b>Lower 95.0%</b>	<b>Upper 95.0%</b>
<b>Intercept</b>	-20.437539	8.7833339	-2.3269	0.0355	-39.2759	1.59916	-39.276	-1.5992
<b>Mean Temperature C</b>	1.309281758	0.2890686	4.5293	0.0005	0.689291	1.929272	0.68929	1.9293
<b>Means Humidity %</b>	0.012598522	0.0618527	0.2037	0.8415	-0.12006	0.145259	-0.1201	0.1453

Table 2: SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.87781874
R Square	0.77056574
Adjusted R Square	0.73778942
Standard Error	2.77080702
Observations	17

Table 3: ANOVA:

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	360.9874	180.4937	23.50983	3.35E-05
Residual	14	107.4832	7.677372		
Total	16	468.4706			

The effect of temperature on mean population is positively significant by keeping the effect of humidity constant. The effect of relative humidity is positively insignificant by keeping the effect of temperature Constant.

Experiment is 73.74% reliable or significant and the rest of the variation (26.26%) is due to some unknown factors.

After this study, it has been recommended that the increased temperature at a limited level and low humidity definitely support fruit fly population to increase. So, the choice of such fruiting varieties which can skip such condition of temperature and humidity or which will mature after passing such supportive condition of environment would be reliable. Sowing of such varieties having hard skin resists the fruit fly to puncture the fruit and don't allow to lay eggs. Also by planting sex pheromone traps would suffer the male population of fruit flies so, female remain unfertilized and population will suffer automatically. In orchards the sanitation under the plants like removal to fallen fruits and dispose off properly will not allow the pupa to hatch into an adult and manage the upcoming population.

Fig 2 : analysis of population of larvae of fruit files

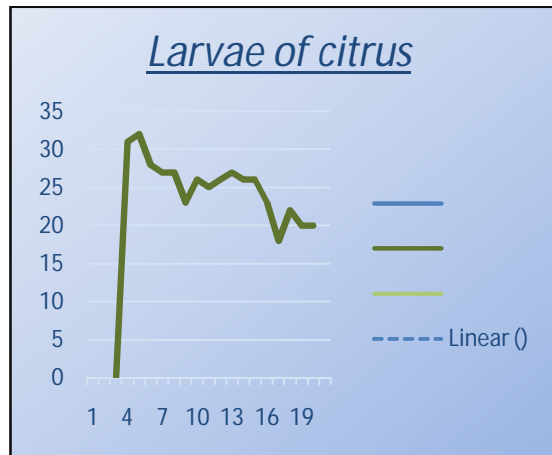


Table 4: RESIDUAL OUTPUT:

<b>Observation</b>	<b>Predicted Mean larval population in Citrus fruits</b>	<b>Residuals</b>
1	20.37697	-3.37697
2	21.71145	3.288552
3	16.6255	0.374497
4	15.26583	-1.26583
5	15.08945	2.910552
6	10.09169	1.908307
7	13.81796	-4.81796
8	12.48348	-0.48348
9	13.84316	-2.84316
10	15.07685	4.923151
11	13.75497	1.245031
12	13.76757	-1.76757
13	10.38146	-0.38146
14	3.847648	0.152352
15	9.021783	-2.02178

16	6.441015	2.558985
17	6.403219	-0.40322

## Conclusion

Fruit fly populations were influenced by food sources and climatic factors. There was a fruit fly population fluctuation that occurred. During this study period, we observed a high population of fruit fly larvae and pupae as temperature increased, as did the population of fruit flies, but only up to a certain temperature threshold. The maximum population of fruit fly in fruits was observed in the month of Mid-November at the lowest humidity and highest temperature, and the lowest population in fruits was observed in the month of December. Temperature and fruit fly population were significantly positively correlated. When humidity was reduced, the population of fruit flies increased, but only up to a certain point of humidity. So, for effective farming and more outcome from fruits and vegetables the management of fruit fly is required and during this management the consideration of abiotic factors including temperature and humidity is significant.

## References

- Khan, M. A., Paul, B., Ahmad, W., Paul, S., Aggarwal, C., Khan, Z., and Akhtar, M. S. (2016). Potential of *Bacillus thuringiensis* in the management of pernicious lepidopteran pests. Springer, International Publishing Switzerland, 36(8): 45-52.
- GiddiThirumala Devi, N. Emmanuel, V. Sekhar, Priyanka Boruah and Kanchan Kumari Gupta (2022). Impact of Integrated Pest Management Practices on Fruit fly and Fruit Borers in Guava cv. Taiwan White. *Biological Forum – An International Journal*, 14(2): 532-539.
- Abbas, M., Hussain, D., Saleem, M., Ghaffar, A., Abbas, S., Hussain, N. and Ghaffar, A. (2020). Integrated Pest Management of Guava, Citrus and Mango Fruitflies at three Districts of Punjab. *Pakistan Journal of Zoology*, pp 1-9.
- Abott, W. S. (1925). A method of computing the effectiveness of insecticide. *Journal of Economic Entomology*, 18(6): 265-267.
- Agrawal, N., Verma, S. K. and Kewal, R. (2019). Plant Extract Approaches to the Management of Guava Fruit Fly *Bactrocera correcta* (Bezzi). *International Journal of Current Microbiology and Applied Sciences*, 8(5): 45- 50
- Mondal, C., Garain, P. K., Maitra, N. J. And Atit, M. (2015). Biofriendly management of guava fruit fly (*Bactrocera correcta* Bezzi) through wrapping technique. *Journal of Applied and Natural Sciences*, 7:358-363.

Vayssieres, J.F., S. Korie and D. Ayegnon, 2009. Correlation of fruit fly (Tephritidae: Diptera) infestation of major mango cultivars in Borgou (Benin) with biotic and abiotic factors and assessment of damage. *Journal of Crop Protection*, 28(6):477-488

Kumar, P., A.L. Abubakar, J.W. Ketelaar and V. Shanmugam, 2011. (IPM project) Field Exercise Guide on Fruit Flies Integrated Pest Management Area-wide Integrated Pest Management of Fruit Flies in South and Southeast Asia.

Allwood, A.J. and R.A.I. Drew, 1996. Strategy for eradication of fruit fly in French Polynesia. *Regional fruit fly project*. 26: 27.

Broufus, G.D., M.I. Pappas, D.S. Koveos, 2009. Effect of Relative humidity on longevity, ovarian maturation and egg production in the fruit fly (Tephritidae: Diptera). *Journal of Annals Entomology Society of American*, 102(1): 70-75.

Sharma, S. K., Punam, J. And Kumar, R. (2016). Management of fruit fly (*Bactrocera* spp.) in cucumber (*Cucumis Sativus* Linn.) grown organically. *Cucumber fruit fly Management. Journal of Biopest*,9(1):7379.

Shimoda, M. And Honda, K. (2013). Insect reactions to light and its applications to pest management. *Applied Entomology and Zoology*, 48: 413–421.

Sookar, P., Bhagwant, S., Allymamod, M. N. (2014). Effect of *Metarhiziumanisopliae* on the fertility and

Fecundity of two species of fruit flies and horizontal transmission of mycotic infection. *Journal of Insect*

*Science*, 14(1): 467-477.

Pakistan Fruits and Vegetables Market-Growth,Trends, COVID-19 impact, and Forecasts (2022 – 2027).

Bagheri, A., Kolyaee, R., Seyahooei, M., A, Najafabadi, S. S.M. and Faraji, G. (2017). Efficacy of methyl eugenol bait traps for controlling the mango fruit fly, *Bactrocera zonata* (Diptera: Tephritidae) *Journal of Crop Production*, 6 (2): 181-189.

Choudhary S. M., Musmade A. M., R. V. Datkhile, V. A.Bodkhe, P. N. Guru. (2022). Effect of pruning time on Fruit fly infestation in guava (*Psidium guajava* L.). *The Journal of Phytopharmacology*, 11(1):47-50.

Dale, N. S. And Patel, R. K. (2010). Population dynamics of Fruit flies (*Bactrocera* spp.) on guava and its Correlation with weather parameters. *Current Biotic*,4(2):245- 248.

Elanchezhyan, K. And Vinothkumar, B. (2015). Neem: An Eco-Friendly Botanical Insecticide in Pest Management. *The Journal of Insect Science*, 116: 207-217.

Firake, D. M., Behere, G. T., Deshmukh, N. A., Thakur, N. S.(2013). Recent Scenario of Insect-pests of Guava in North East India and their Eco-friendly Management. Indian Journal of Hill Farming, 26 (1): 55-57.

Khan M. M., Shah S. W. H., Akhter I. And Malik H. (2017). Integrated pest management of fruit flies in guava orchards. Journal of Entomology and Zoology Studies, 5(2): 135-138.

Bana, J.K., Sharma, H., Kumar, S., Singh P. 2017. Impact of weather parameters on population dynamics of oriental fruit fly, *Bactrocera Dorsalis* (Hendel) (Diptera: Tephritidae) under south Gujarat mango ecosystem. J. Agrometeorol. 19: 78–80.

Choudhary, J., Naaz, N., Chandra P., Bikash, D., Sudarshan, M., Shivendra, K. 2014. Field guide for identification of fruit fly species of genus *Bactrocera* prevalent in and around mango orchards. In: Technical booklets No.: R-43/Ranchi-16. ICAR Research Complex for Eastern region, Research Centre. Ranchi, India, pp. 1–16.

Khan, M.H., Khuhro, N.H., Awais, M., Asif, M.U., Muhammad, R.2021. Seasonal abundance of fruit fly, *Bactrocera* species (Diptera:Tephritidae) with respect to environmental factors in guava and mango orchards. Pak. J. Agric. Sci. 34: 266–272.  
[doi.org/10.17582/journal.pjar/2021/34.2.266.272](https://doi.org/10.17582/journal.pjar/2021/34.2.266.272)

Mahmood, K. And Mishkatullah. 2007. Population Dynamics of three species of genus *bactrocera* (Diptera: Tephritidae: Dacinae) in Bari, Chak-Wal (Punjab). Pak J. Zool., 39: 123-126.