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

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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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.

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Keywords: Bactrocera dorsalis; fruit fly; abiotic factors; pheromone traps; methyl eugenol.

1. 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 [1,2]. 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 [3,4]. 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 [5]. The 440 species of tefritides that make up the genus bactrocera are mostly found in tropical Asia, southern Pakistan, and Australia [6]. Host species 173 and 125 respectively of *B. dorsalis* and B. cucurbitae are the most significant fruit tree pests in Hawaii [7]. *B. dorsalis* is the most common and widespread species [8]. 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 [9-12]. 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 [13-17]. Oriental fruit flies acquire destructive status only in subtropical habitats [18-22]. 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 [23-25]. The larvae feed on fruits and rot the pulp of fruits and vegetables. Sanitation is the most effective way to combat fruit fly infestations [26-29]. 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.

2. MATERIALS AND METHODS

2.1 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, Police lines, 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.

3. 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 humidity28% 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.

4. 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 [30-32]. 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.

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.

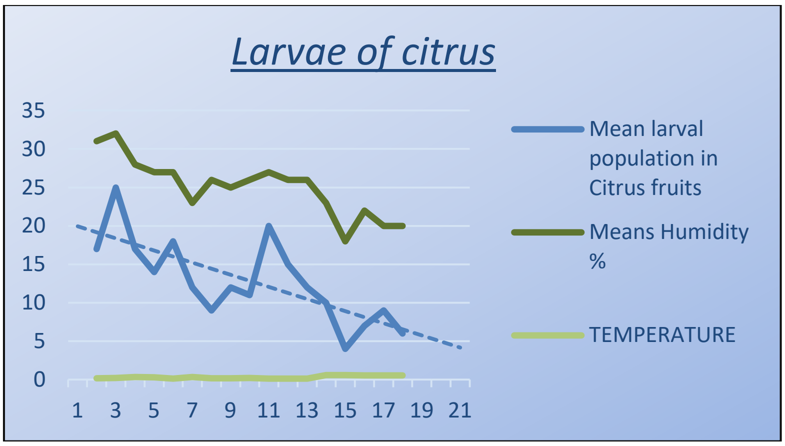

Fig. 1. Comparative analysis of population of larvae of fruit files in citrus garden during study period

Table 1. Statistical results

	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***	***Lower 95.0%***	***Upper 95.0%***
Intercept	-20.437539	8.7833339	-2.3269	0.0355	-39.2759	-1.59916	-39.276	-1.5992
Mean Temperature C	1.309281758	0.2890686	4.5293	0.0005	0.689291	1.929272	0.68929	1.9293
Means Humidity %	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

Sowing of such varities 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.

Table 3. ANOVA

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

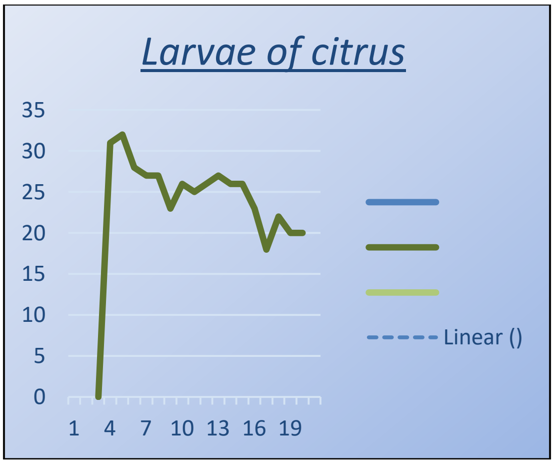

Fig. 2. Analysis of population of larvae of fruit files

Table 4. Residual output

Observation	**Predicted mean larval population in citrus fruits**	**Residuals**
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

5. 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 manage ment of fruit fly is required and during this management the consideration of abiotic factors including temperature and humidity is significant.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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