Original Research Article

Impact of Weather Parameters on Population Dynamics of fruit flies(*Bactrocera*sp.) on Phalsa (*Grewia asiatica* Linn.)

Abstract

Field experiments were meticulously conducted for two consecutive years (2018 and 2019) at a phalsa orchard situated in the Regional Horticulture Research Station (RHRS), Raya, District-Samba. The primary aim of these experiments was to comprehensively examine the population dynamics of fruit flies and their susceptibility to variations in weather parameters. To this end, green valley fruit fly traps were strategically deployed throughout the orchard to monitor fruit fly populations. The outcomes of the study revealed that fruit fly activity commenced during the 15th standard week and reached its zenith during the 24th standard week in both years. Correlation analysis underscored a notably strong and positive correlation with maximum (0.575**) and minimum (0.696**) temperatures. Furthermore, a significant negative correlation (–0.422*) was observed between morning relative humidity and fruit fly catches. However, the study did not find any statistically significant correlation between evening relative humidity, rainfall, and fruit fly captures. The weather conditions accounted for an impressive 59.70% of the observed variations in adult fruit fly trap catches of *B. dorsalis* and *B. zonata* on phalsa which highlighted the intricate interplay between environmental factors and the population dynamics of these fruit fly species in the phalsa crop ecosystem.

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Keywords: *Bactrocera dorsalis, Bactrocerazonata*, phalsa, correlation, weather parameters

Introduction

Phalsa (*Grewia asiatica* Linn.: family Tilliaceae), commonly known as star apple, holds a paramount position as an underutilized fruit crop extensively cultivated in the arid and semi-arid regions of India. The cultivation of phalsa is currently experiencing a surge in ~~our~~ thecountry, owing to its abundance of bioactive compounds that augment the nutritional profile of human diets, thereby promoting overall human well-being (Diamantiet al., 2012). In the state of Jammu and Kashmir, commercial cultivation of phalsa is yet to be established; however, it thrives in the Kandi and dry land areas of Kathua, Samba, Jammu, Udhampur, Rajouri, and Reasi districts, offering promising prospects for a readily accessible market. Nevertheless, the production of phalsa fruit faces diverse challenges, with insect pests emerging as a prominent hindrance, resulting in substantial losses in crop yield. A myriad of insect pests and their detrimental impacts have been reported across various regions of India (Mann, 1994; Day, 1996; Mani and Krishnamurthy, 1996; Sridhar et al., 2001). Notably, fruit flies, primarily belonging to the *Bactrocera* genus, stand out as consequential agents causing significant damage to phalsa crops. The *Bactrocera* genus encompasses a wide spectrum of over 75 species, exhibiting broad yet primarily allopatric distributions, with regions of transition prevalent in Southeast Asia (Clarke et al., 2005; Krosch et al., 2013). Extensive research has identified *Bactrocera dorsalis* as the most deleterious among these species (Mwatawala et al., 2006; José et al., 2013), with discernible morphological variations observed within their populations. The damage inflicted is attributed to the maggots, which internalize within phalsa berries, leading to premature fruit detachment. Reports indicate that fruit damage can escalate up to a staggering 63% in Punjab (Mann, 1994), with the afflicted fruits typically hosting solitary fly pupae. The injury to the fruit transpires through oviposition punctures, followed by larval development. Monitoring and managing immature fruit fly stages within the field setting pose considerable challenges, as the maggots remain ensconced within the fruit, while pupation and overwintering transpire in the soil. Consequently, vigilant monitoring becomes imperative to gauge fluctuations in fruit fly population levels and execute appropriate control measures (Sharma et al., 2015). The intricate interplay of climatic elements, such as temperature, rainfall, and relative humidity, significantly influences the dynamics of insect populations (Siswanto et al., 2008). Previous studies by Agarwal and Pramod Kumar (1999) demonstrated peak fly populations during the third week of June, juxtaposed with nadirs observed in the final week of August. Bearing in mind the paramount importance of berry fruits and the conundrum posed by fruit flies, intensive investigations concerning the population dynamics of fruit flies were undertaken.

Materials and Methods

A well-established phalsa orchard located at the Regional Horticulture Research Station (RHRS) in Raya, District-Samba, Jammu, and Kashmir, was selected as the experimental site to investigate the population dynamics of fruit flies for two consecutive years (2018 and 2019). To monitor the adult fruit fly population, Green Valley fruit fly traps were strategically deployed in the experimental phalsa orchards at a density of 10 traps per hectare (Fig 1). The incidence of fruit flies was closely observed and recorded immediately after their emergence throughout the entire cropping period. Weekly trap catches were meticulously documented to track the temporal variations in fruit fly populations during the phalsa cropping season. Concurrently, weather data, comprising temperature, relative humidity, and rainfall, were obtained from the meteorological observatory, SKUAST-Jammu, for subsequent correlation and regression analysis. The primary objective of this study was to establish a correlation between fruit fly populations and prevailing weather conditions, thereby elucidating the key factors influencing their presence and abundance in the phalsa orchard.

Comment [I2]: How far apart were the traps?

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Comment [I4]: What statistical software was used to analyze the data?

Results and Discussion

The two-year survey recorded the prevalence of two fruit fly species, namely *Bactrocera dorsalis* and *B. zonata*, as pests of the phalsa crop. The data on weekly mean trap catches of fruit flies revealed that the fruit fly activity began during the 15th week of the year 2018 and increased in the subsequent weeks, reaching its peak during the 24th week. This peak coincided with the maximum fruit maturity of phalsa. During the 24th week, the maximum temperature recorded was 38.6°C, and the minimum temperature was 26.1°C, which contributed to the increased captures of adult fruit flies. The relative humidity in the morning and evening was recorded as 58.3% and 34.0%, respectively. In the following weeks, the fruit fly population declined. It is worth noting that no abnormality in the fruit fly population was observed in the trap catches during the experimentation period, likely due to the availability of many other food sources. (Refer to Fig 2 for a graphical representation of the data). A similar pattern of adult fruit fly trap catches was observed during the year 2019 on the phalsa crop. The maximum number of adult fruit flies (81.67 fruit flies per trap per week) was recorded during the 24th week. During this period, the mean maximum and minimum temperatures were 41.1°C and 23.7°C, respectively. The relative humidity in the morning and evening was 51.0% and 29.1%, respectively, and the recorded rainfall was 11.6 mm (Refer to Fig 3 for a graphical representation of the 2019 data). The results of our study are in agreement with the earlier investigations conducted by Mann (1994), who reported the presence of one adult or pupa per fallen fruit and 0.73-0.78 adults or pupae per picked fruit. Additionally, Chen and Ye (2007) documented the incidence of the fruit fly, *B. dorsalis*, starting from April, with the population reaching its peak during the fruiting period of the host plant, providing further support for our present findings. Their study revealed a continuous increase in population until 25th May, followed by a slowdown in activity during June, possibly attributed to rainfall or temperature fluctuations. These trends suggest that the fruit fly population might be sustained or further increased in the subsequent months, as postulated by Chen and Ye (2007). The collective evidence from these referenced studies enhances the validity of our findings and contributes to a deeper understanding of the population dynamics of *Bactrocera* sp. in relation to seasonal variations and environmental factors.

Correlation and Regression analysis

The pooled correlation studies between fruit flies and weather parameters revealed a highly significant positive correlation between weekly mean maximum and minimum temperatures (0.575** and 0.696**, respectively) and adult fruit fly trap catches. Moreover, a significant negative correlation (–0.422*) was found between morning relative humidity and fruit fly catches. However, the correlation between evening relative humidity and rainfall with fruit fly catches showed non-significant negative correlation. We calculated the linear regression equation for adult fruit fly trap catches of *Bactrocera dorsalis* and *B. zonata*on the phalsa crop. The equation is as follows: $Y = -178.238 + 3.769X1 + 2.312X2 - 0.486X3 + 1.581X4 - 0.515X5$. The coefficient of determination (R^2) for fruit fly trap catches was found to be 0.597, indicating that approximately 59.7% of the variability in fruit fly trap catches can be explained by the included weather factors. The overall impact of weather factors on adult fruit fly trap catches of *B. dorsalis* and *B. zonata* on phalsa was determined to be 59.70%. This highlights the significant influence of weather conditions on the population dynamics of these fruit fly species on the phalsa crop.Our current findings align with the research conducted by Ye et al. (2012), who also observed a negative correlation between fruitflies and rainfall. This consistency strengthens the validity of our conclusions. Furthermore, our results find additional support from the studies conducted by Mishra et al. (2012) and Abbas et al. (2018), where they reported a positive correlation between fruit flies and temperature and a negative correlation with relative humidity. Similarly, Kannan and Rao (2006) demonstrated a significant positive relationship between fruit flies and maximum temperature, while showing negative correlations with both rainfall and relative humidity. These collective findings from various studies reinforce the robustness of the associations between fruit fly dynamics and weather parameters, enhancing our understanding of the intricate interplay between these factors in shaping fruit fly populations.

Comment [I5]: Do these numbers represent p? What is the significance level?

Comment [I6]: P<0.05??

Comment [I7]: P=???

Comment [I8]: Your conclusion is not complete

Conclusion

The field experiments conducted over two consecutive years yielded valuable insights into the population dynamics and behaviour of fruit flies in relation to weather conditions. The findings revealed a consistent pattern of fruit fly activity, with peak activity observed during the 24th standard week in both years. This recurring seasonal trend indicated a robust and predictable behavioural pattern of fruit flies concerning the phalsa crop. Moreover, the correlation analysis provided compelling evidence of the significant impact of weather parameters on the abundance of fruit flies. These results have important implications for phalsa crop management and pest control strategies. An understanding of the seasonal pattern of fruit fly activity can help farmers and researchers to implement timely interventions to mitigate fruit fly damage and safeguard crop yield. Additionally, the relationship between temperature and fruit fly abundance provides valuable knowledge for developing targeted and climate-informed pest management approaches.

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Comment [I10]: Humidity and rainfall are overlapping factors and this conclusion is not correct with only two abiotic factors
Are biological factors such as competition also investigated?

References

Abbas, Q., Hasnain, M., Hussain M., Ali Q., Jaffir, M., Shahid, M., Iqbal, M. and Abbas, H. (2018). Studies on the population dynamics of fruit flies (Diptera:Tephritidae) on mango orchards in Multan, Punjab, Pakistan. Journal of Pure and Applied Agriculture, 3(1): 42-48.

Agarwal, M. L. and Pramod Kumar (1999). Effect of weather parameters on population dynamics of peach fruit fly, Bactrocerazonata (Saunders). Entomon, 24(1): 81-84

Chen P. and Ye, H. 2007. Population dynamics of *Bactrocera dorsalis* (Diptera: Tephritidae) and analysis of factors influencing populations in Baoshanba, Yunnan, China. Entomological Science, 10(2): 141-147.

Chen, P., Ye, H., & Liu, J. (2006). Population dynamics of *Bactrocera dorsalis* (Diptera: Tephritidae) and analysis of the factors influencing the population in Ruili, Yunnan Province, China. Acta EcologicaSinica, 26(9), 2801-2808.

Clarke, A. R.,Armstrong K.F., Carmichael, A.E., Milne, J.R., Raghu, S., George K. R. and Yeates, D.K. (2005). Invasive phytophagous pests arising through a recent tropical evolutionary radiation: the *Bactrocera dorsalis* complex of fruit flies. *Annu. Rev. Entomol.* **50**, 293–319.

José, L., Cugala, D. and Santos, L. Assessment of invasive fruit fly fruit infestation and

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damage in Cabo Delgado Province, Northern Mozambique. *African CropSci. J.* **21**, 21–28 (2013).

K. Sharma, R. K. Sharma, S. Chander, and V. Jilu. 2015. Effects of weather parameters on Guava fruit fly (Bactrocerazonata) population at IARI, New Delhi. Vol. 17, No. 2 Journal of Agrometeorology 17 (2) : 227-229.

Krosch, M. N., Schutze MK., Armstrong KF., Boontop Y., Boykin LM., *et al*. Piecing together an integrative taxonomic puzzle: microsatellite, wing shape and aedeagus length analyses of *Bactrocera dorsalis* (Diptera: Tephritidae) find no evidence of multiple lineages in a proposed contact zone along the Thai/Malay Peninsula. *Syst. Entomol.* **38**, 2–13 (2013).

Mann GS. 1994. Fruit flies as pests of phalsa, *Grewia asiatica* Most in Punjab. Journal of Insect Science 7(2):136-137.

Mishra, J., Singh, S., Tripathi, A., &Chaube, M. N. (2012). Population dynamics of oriental fruit fly, *Bactocera dorsalis* (Hendel) in relation to abiotic factor. HortFlora Research Spectrum, 1(2), 187-189.

Mwatawala, M. W., DeMeyer, M., Makundi, R. H. &Maerere, A. Biodiversity of fruit flies (Diptera,Tephritidae) in orchards in different agro-ecological zones of the Morogoro region, Tanzania. *Fruits* **61**, 321–332 (2006).

Siswanto, Rita, M., Dzolkhifli, O. and Elna, K. (2008). Population fluctuation of *Helopeltisantonii* Signoret on Cashew *Anacardium occidentalle* L. in Java Indonesia. Pertanika J. Trop. Agric. Sci., 31: 191-196.

Ye, W., Lin, Lailang S, Chun and Dong, W. 2012. Daily activity and spatial distribution pattern of the oriental fruit fly, *Bactrocera dorsalis* (Diptera:Tephritidae) in mango orchard, Yuanjiang, Yunnan. Acta EcologicaSinica, 32(16): 5199-5207.

Day, W.H. 1996. Evaluation of biological control of the tarnished plant bug (Hemiptera:Miridae) in alfalfa by the introduced parasite *Peristeusdigoneutis* (hymenoptera: Braconidae). *Environmental Entomology*, **25**:512-518.

Sridhar, V., Singh, H. S. and Pandey, V. 2001. Record of ant pests on Lasoda and Phalsa crops in Coastal Orissa. Insect Environment, 7: 70.

Diamanti J, Capocasa F, Balducci F, Battino M, Hancock J, Mezzetti B. 2012. Increasing

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strawberry fruit sensorial and nutritional quality using wild and cultivated germplasm. Plos One,7:1-16.

Mani, M. and Krishnamoorthy, A. 1996. Record of two Insect pests and their natural enemies on phalsa. Journal of Insect Science, 9:182.

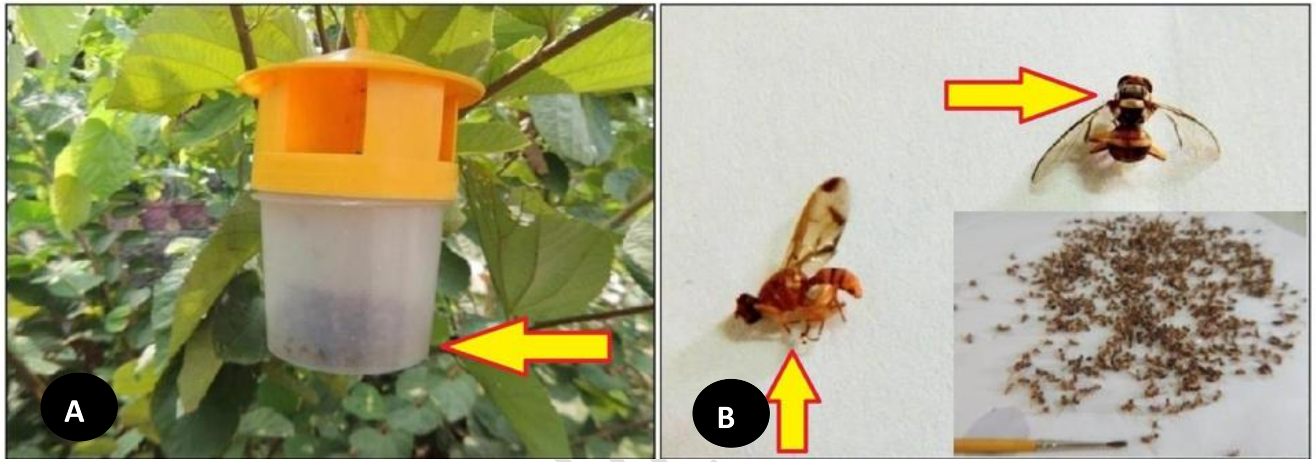

Fig 1. Green valley fruit fly traps installed in phalsa crop (A); Trap catches and two different species of fruit flies collected on phalsa (B)

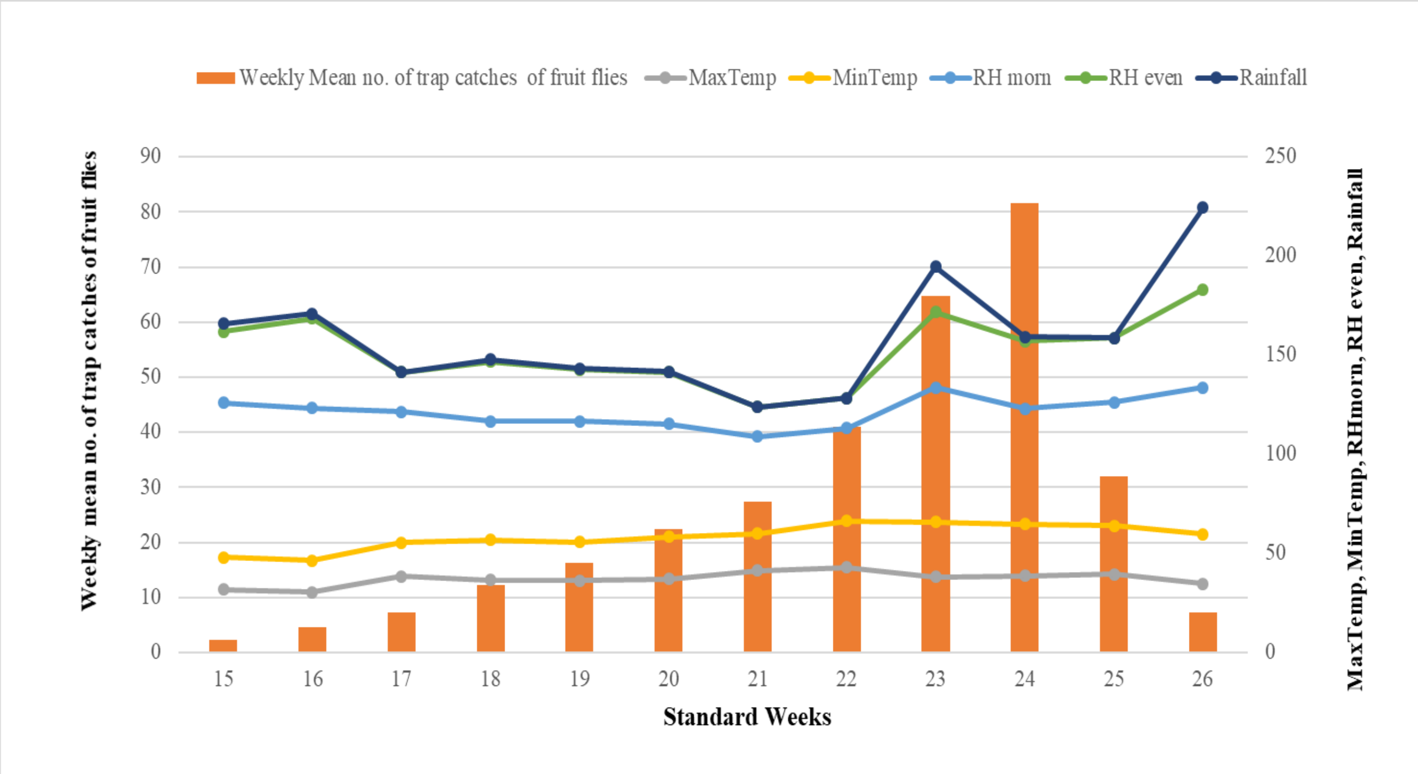

Fig.2: Trap catchesoffruitfliesin relation to weather parameters onphalsa during 2018

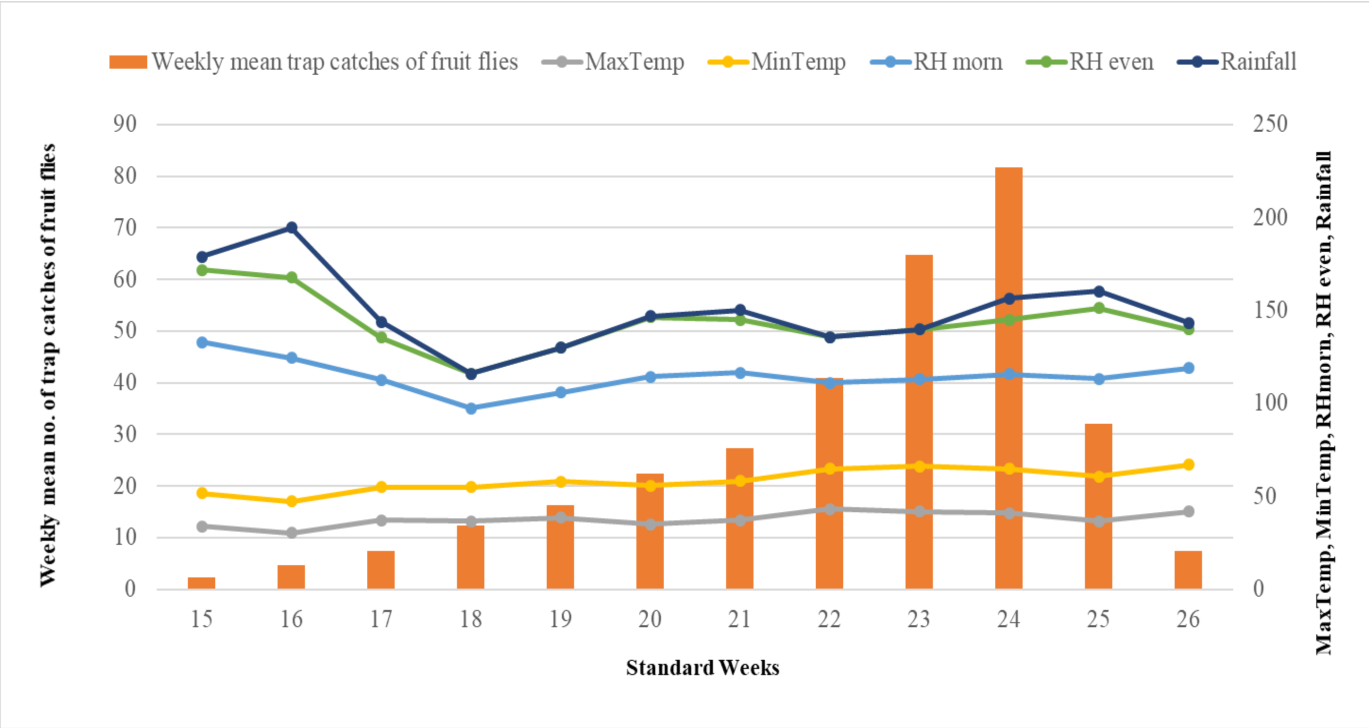

Fig.3:Trap catchesoffruitflies in relation to weather parameters onphalsa during 2019

Table1: Pooled Correlationmatrixofadultfruitfliestrapcatchesonphalsainrelationtoabioticfactors(2018-19)

S.No.	Insectpests	Temperature(°C)		Relativehumidity(%)		Rainfall(mm)
		Maximum	Minimum	Morning	Evening	
1	Fruitfliestrapcatches of*Bactroceradorsalis &B. zonata*	0.575**	0.696**	– 0.422*	– 0.090	– 0.050

**Correlationis significantat the0.05 level(2-tailed)

*Correlationis significantat the0.01 level(2-tailed)

Table2: Regressionequationandcoefficientofmultipledetermination(R^2)ofadultfruitflytrapcatchesonphalsainrelationto

abioticfactors (2018-19)

Insectpests	**Regressionequation**	**Correlationcoefficient(r)**	**Coefficient ofdetermination (R^2)**	**Coefficient ofvariation(%)**
Fruitfliestrap catches of *B. zonata* and *B. dorsalis*	$Y=-178.238+3.769X_1+2.312X_2-0.486X_3+1.581X_4-0.515X_5$	0.772	0.597	59.70

Where,

Y= trap catches of fruit flies;

X_1= Maximum Temperature(°C)

X_2=Minimum Temperature(°C)

X_3= Morning Relativehumidity(%)

X_4= Evening Relativehumidity(%)

X_5= Rainfall (mm)