Original Research Article

Population Dynamics of Fruit Fly, *B. dorsalis* (Hendle) on Mango and Correlation with Weather Parameters

ABSTRACT

Investigation on the population dynamics of fruit fly *Bactrocera dorsalis* (Hendle) (Diptera: Tephritidae) was carried out by installing "Nauroji-Stonehouse Fruit Fly Trap" in the mango orchard of organic farm, Navsari Agricultural University, Navsari, Gujarat, India during 2021-22. The population of *B. dorsalis* prevailed throughout the year in mango orchard with its peak activity from 14^{th} SW to 31^{st} SW which coincided with the fruiting and harvesting period of fruits. The population of *B. dorsalis* decreased from August to February. Correlation analysis revealed a significant positive correlation of population of *B. dorsalis* with maximum temperature, minimum temperature, average temperature, evening relative humidity, average relative humidity, rainy days, rainfall and wind velocity but a significant negative correlation with duration of bright sunshine hours. However, there was a nonsignificant correlation of population of *B. dorsalis* with morning relative humidity.

Key Words: *B. dorsalis*, mango, population dynamics, correlation, weather parameters, south Gujarat

1. INTRODUCTION

Mango, *Mangifera indica* (L.), belongs to the family Anacardiaceae, is known as "king of fruits" which is widely cultivated in tropical and subtropical regions of the world (Lakshminarayana, 1980; Majumdar and Sharma, 1990; Scherrer, 2007). It originated in the Indo-Burma region. It is the national fruit of India, Pakistan and the Philippines. India ranks first among world's mango producing countries of the world and ranks third for the export of mango. The area under mango cultivation in India is 2.29 million hectares with production of 20.44 metric tonnes and productivity of 8.90 metric tonnes per hectare (Indian Horticulture Database, 2019-20). The mango crop is attacked by about 492 species of insects, 17 species of mites and 26 species of nematodes at the world level (Pena et al., 1998). Of these, 188 species of insects have been reported from India (Tandon and Verghese, 1985). One of which is the damage caused by fruit fly (Ekesi et al., 2011; Badii et al., 2015), which attack various kinds of fruits found all over the world (White and Harris, 1992). They are regarded as the quarantine pests (Jena et al., 2022a; Jena et al., 2022b; Jena et al., 2022c). The annual loss of fruits and vegetables by fruit flies is about 144.40 million US dollars (Stonehouse et al., 2002). In India, fruit flies cause crop loss up to Rs. 29,460 million per annum in mango, guava, sapota and citrus (Mumford, 2001; Mishra et al., 2012). Among various species of fruit fly, three species *viz*., *B. dorsalis*, *B. zonata* (Saunders) and *B. correcta* (Bezzi) are considered as economically important pests infecting mango crop (Choudhary et al., 2012 and Verghese et al., 2006). The oriental fruit fly B. dorsalis was first reported in Taiwan Island (Wei et al., 2017) and is a serious pest on a wide range of fruit crops in the Indian subcontinent. It is endemic to Southeast Asia, but has also been introduced to various region of the world and became threats to the wide range of cultivated and wild fruits (Drew and Raghu, 2002). The *B. dorsalis* reported to cause 100.0, 87.0, 78.0 and 61.0 per cent fruit damage in rainy season on guava, mango, peach and pear, respectively (Sharma et al., 2011). Whereas Singh (2010) reported significant losses in Kinnow due to fruit flies. They are invasive pests of horticultural crops worldwide due to high reproductive rate, shorter generation and doubling time, extreme polyphagy, high mobility and wider adaptability to new environments (Mohamed et al., 2012; Prokopy, 1977; Sharma et al., 2011; Jena et al., 2022a). Moreover, the damaging stage is the maggot which feeds on the pulp of the fruit and remains unexposed to the chemical pesticides. Therefore, it is very difficult to manage the pest. Hence, development of an integrated management package is a pre-requisite to manage this pest. Looking to the importance of the pest, the present investigation was carried out on population dynamics of *B. dorsalis* and correlation with weather parameters in the mango orchard.

2. MATERIALS AND METHODS

The present investigation on population dynamics of *B. dorsalis* on mango was carried out starting from April 2021 to March 2022 at the mango orchard, organic farm, Navsari Agricultural University, Navsari, Gujarat, India. For this study mango orchard of one hectare with *var*. Kesar was selected which was kept free from the insecticidal spray.

In this study ten Methyl eugenol based "Nauroji Stonehouse Fruit Fly Traps" were installed by keeping trap to trap distance of 30 m for monitoring the population of *B. dorsalis* round the year. The data on number of adult males of *B. dorsalis* caught per ten traps were recorded at weekly interval. The influence of weather parameters viz., maximum temperature, minimum temperature, morning and evening relative humidity and rainfall were worked out by statistical correlation and regression analysis.

3. RESULTS AND DISCUSSION

Data recorded during 2021-22 are presented in table 1 and depicted in figure 1 and 2. The data revealed that the *B. dorsalis* population was observed throughout the year with its peak activity from 14^{th} Standard Meteorological week (SW) to 31^{st} SW. The maximum number of male *B. dorsalis* (322) were trapped in 28^{th} SW, which exhibited the peak of population of *B. dorsalis* in the area whereas the minimum number of *B. dorsalis* (41) were trapped in 14^{th} SW, which exhibited the least of population of *B. dorsalis* in the area. The population of *B. dorsalis* decreased from August to February. The peak activity of *B. dorsalis* population in mango orchard coincided with fruiting and harvesting period of fruits.

Observation on occurrence of *B. dorsalis* throughout the year and peak activity coincided with fruiting and harvesting period of mango has been made earlier by Dale (2002) who revealed that the population remained throughout the year and highest fly population coincided with the maturity and harvesting period of mango in mango orchard at north Gujarat. Dale (2002) reported that the maximum activity coincided with the fruiting season in guava orchard at north Gujarat; the population recorded throughout the year in sapota orchard, north Gujarat (Dale, 2002); the highest fruit fly infestation (36.67%) coincided with ripening cum harvesting period of mango at Navsari Agricultural University, Navsari, Gujarat (Patel et al., 2013); the population prevailed throughout the year and coincided with the maturity and harvesting period of sapota at Navsari Agriculture University, Navsari, Gujarat (Amol et al., 2014); the population prevailed throughout the year and coincided with the maturity and harvesting period of sapota at Gandevi, south Gujarat (Nandre and Shukla, 2014); the maximum catches coincided with fruiting and harvesting stages of the crop at

Navsari Agricultural University, Paria, Gujarat (Bana et al., 2017); the maximum population coincided with fruiting period of mango at N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat (Bansode and Patel, 2018); the fruit fly was active throughout the year in the mango orchard at the mango orchard, College of Agriculture, Navsari Agricultural University, Bharuch, Gujarat (Patel et al., 2019); the maximum population coincided with fruiting period of guava at N. M. College of Agriculture, Navsari, Gujarat (Bansode and Patel, 2020) which are in favour of the present findings.

During present studies, the activity of *B. dorsalis* was higher during April to July in south Gujarat with peak activity in 28th SW and least in 14th SW. A more or less similar trend was found by Dale (2002) who recorded that the population was higher in the month of July and August, while the lowest population was recorded in the month of January and December in mango orchard at north Gujarat; the population peaked in the month of July and August whereas it was the lowest in the month of January and March in sapota orchard, north Gujarat (Dale, 2002); the highest population was recorded during the month of April to August in sapota orchard at Gandevi, Gujarat (Anonymous, 2007); the highest infestation (36.67%) was on 22nd SW in mango orchard at Navsari Agricultural University, Navsari, Gujarat (Patel et al., 2013); the maximum activity (172.10 flies per trap) was found during March to August, whereas population was found to be lower during month of December and January (11.10 to 21.30 flies per trap) in sapota orchard at Navsari Agricultural University, Navsari, Gujarat (Amol et al., 2014); The maximum activity (172.10 flies per trap) during March to August and population was found to be lower during month of December and January (11.10 to 21.30 flies per trap) in sapota orchard at Gandevi, south Gujarat (Nandre and Shukla, 2014); the maximum catches during April to July at Navsari Agricultural University, Paria, Gujarat (Bana et al., 2017); the maximum population during the month of April to July and the population decreased during December to February at N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat (Bansode and Patel, 2018); the maximum catches (128.60 fruit flies/trap) in 28th standard meteorological week (SW) *i.e.*, ninth to 15th July, while minimum catches (4.47 fruit flies/trap) in third standard meteorological week (SW) *i.e.*, 15th to 21st January at the mango orchard, College of Agriculture, Navsari Agricultural University, Bharuch, Gujarat (Patel et al., 2019).

Table 1: Population of *B. dorsalis* in different months in mango orchard (April, 2021 to May, 2022)

Sr. No.	SW	Number of *B. dorsalis* caught/10 traps	Sr. No.	SW	Number of *B. dorsalis* caught/10 traps
1	14	41	27	40	146
2	15	190	28	41	152
3	16	204	29	42	160
4	17	219	30	43	172
5	18	232	31	44	165
6	19	216	32	45	120
7	20	202	33	46	160
8	21	196	34	47	190
9	22	182	35	48	97
10	23	230	36	49	100
11	24	240	37	50	96
12	25	231	38	51	93
13	26	280	39	52	82
14	27	310	40	1	150
15	28	322	41	2	92
16	29	288	42	3	80
17	30	292	43	4	76
18	31	297	44	5	120
19	32	304	45	6	136
20	33	252	46	7	102
21	34	228	47	8	170
22	35	147	48	9	172
23	36	138	49	10	192
24	37	122	50	11	202
25	38	137	51	12	220
26	39	126	52	13	170

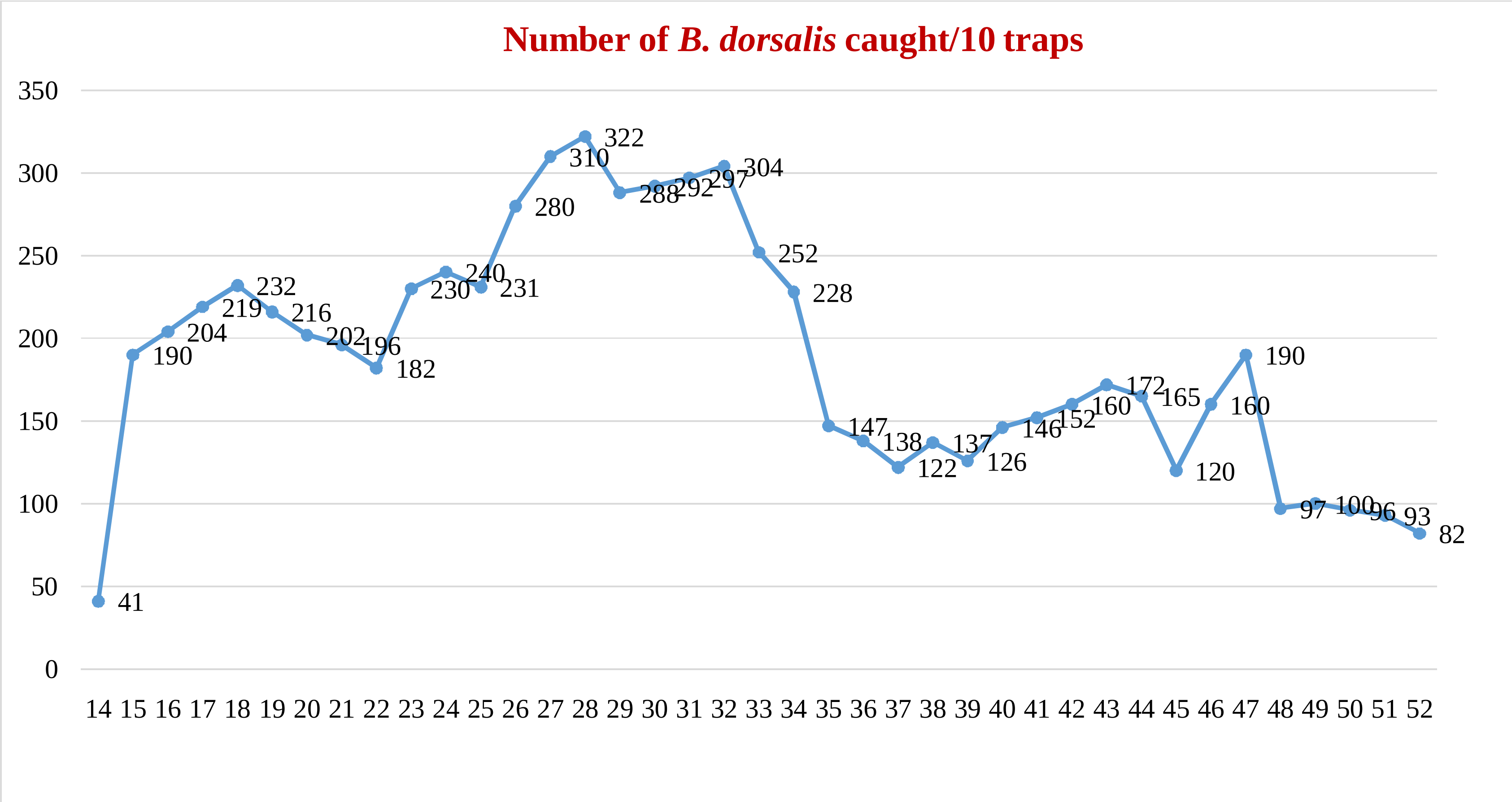

Figure 1: Population of *B. dorsalis* from 14th to 52nd SW in mango orchard

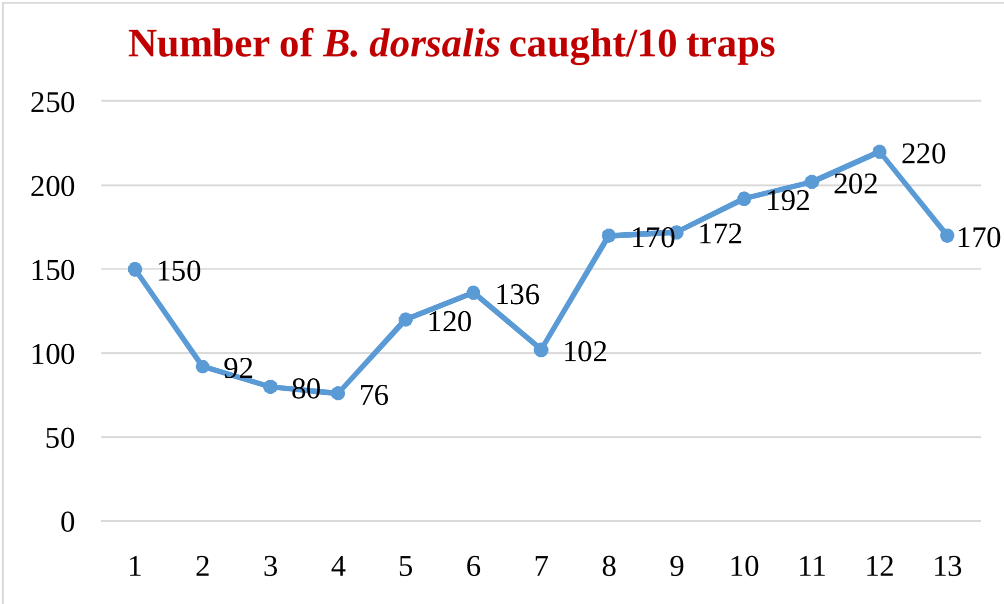

Figure 2: Population of *B. dorsalis* from 1st to 13th SW in mango orchard

3.1 Correlation and multiple regression studies between population of *B. dorsalis* in mango orchard and weather parameters

The data on population of *B. dorsalis* recorded during the period April, 2021 to March, 2022 are correlated with different weather parameters and have been presented in table 2. Data indicated a significant positive correlation with maximum temperature, minimum temperature, average temperature, evening relative humidity, average relative humidity, rainy days, rainfall and wind velocity but a significant negative correlation with duration of bright sunshine hours. However, there was a nonsignificant correlation of population of *B. dorsalis* with morning relative humidity.

The present findings are more or less alike with those of Kumar et al. (1997) who found that there was a significant positive correlation with temperature (minimum and average), relative humidity (minimum, maximum and average), rainfall and rainy days, but a significant negative correlation with sunshine hours in sapota orchard in Paria, Gujarat; a significant positive correlation with temperature (minimum and average), relative humidity (minimum, maximum and average), rainfall and rainy days while a significant negative correlation with sunshine hours in mango orchard at north Gujarat (Dale, 2002); a significant positive correlation with minimum temperature, relative humidity (maximum, minimum and average) and rainy days whereas, negative correlation with maximum temperature, sunshine hours and rainfall in guava orchard at north Gujarat (Dale, 2002); a significant positive correlation with temperature (minimum and average), relative humidity (maximum, minimum and average), rainfall and rainy days, whereas negative correlation with maximum temperature and sunshine hours in sapota orchard north Gujarat (Dale, 2002); the infestation increased with increase in temperature, relative humidity, wind velocity and evaporation at Navsari Agricultural University, Navsari, Gujarat (Patel et al., 2013); The population had significantly positive correlation with temperature (maximum, minimum and average) and morning relative humidity whereas, it had positive nonsignificant correlation with average relative humidity and rainfall. Furthermore, a negative correlation with the maximum relative humidity in sapota orchard at Navsari Agricultural University, Navsari, Gujarat (Amol et al., 2014); A significantly positive correlation with temperature (maximum, minimum and average) and morning relative humidity whereas, it has positive nonsignificant correlation with average relative humidity and rainfall. Also, a negative correlation with the maximum relative humidity in sapota orchard at Gandevi, south Gujarat (Nandre and Shukla, 2014); a positive correlation of population of *B. dorsalis* with temperature (maximum, minimum and average), relative humidity (maximum, minimum and average), rainfall and wind velocity at N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat (Bansode and Patel, 2018); a significant positive correlation between minimum temperature, morning relative humidity, evening relative humidity, wind velocity and rainfall with fruit fly population while, a significant negative correlation with sunshine hours at the mango orchard, College of Agriculture, Navsari Agricultural University, Bharuch, Gujarat (Patel et al., 2019); a positive correlation with temperature (maximum, minimum and average), relative humidity (maximum, minimum and average), rainfall and wind velocity at N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat (Bansode and Patel, 2020).

The coefficient values of multiple regression analysis are presented in table 2. The various parameters utilized for prediction of population of *B. dorsalis* gives 55.55 per cent coefficient of determination due to temperature, relative humidity, rainfall, wind velocity and bright sunshine hours. Therefore, it can be stated that the variation ($R^2 = 0.555$) in population of *B. dorsalis* was due to the above factors.

Table 2: Effect of weather parameters on population of *B. dorsalis* in mango orchard (April, 2021 to May, 2022)

Weather parameters		Correlation coefficients	Regression Coefficients
(X_1)	Max. Temp. (^oC)	0.27*	-0.918

(X_2)	Min. Temp. (^oC)	0.69**	13.598
(X_3)	Mean Temp. (^oC)	0.64**	--
(X_4)	M. R.H. (%)	-0.05	-0.486
(X_5)	E. R.H. (%)	0.41**	-1.318
(X_6)	Mean R.H. (%)	0.31*	--
(X_7)	Rainy days (day)	0.38**	--
(X_8)	Rainfall (mm)	0.29*	-0.017
(X_9)	Wind velocity (km/h)	0.49**	5.353
(X_{10})	Bright sunshine hours (h)	-0.32*	-4.763
R^2	Coefficient of determination	--	0.55
CV	Coefficient of variation (%)	--	55.55
R value	Multiple Correlation Coefficient	--	0.74
a value	Intercept	--	65.45

N=52, *Significant at the level of 5%, **Highly Significant at the level of 5%

Regression equation for the prediction of population of *B. dorsalis* on mango is as below,

$$Y = 65.458 - 0.918 X_1 + 13.598 X_2 - 0.486 X_4 - 1.318 X_5 - 0.017 X_8 + 5.353 X_9 - 4.753 X_{10}$$

Where Y = Predicted population of *B. dorsalis*

X_1 = Maximum temperature

X_2 = Minimum temperature

X_4 = Morning relative humidity

X_5 = Evening relative humidity

X_8 = Rainfall

X_9 = Wind velocity

X_{10} = Bright sunshine hours

So, looking to the relationship of abiotic factors with population of *B. dorsalis*, it may be drawn that population of *B. dorsalis* was positively influenced by temperature (maximum, minimum and average), relative humidity (evening and average), rainfall, rainy days and wind velocity but negatively related to the duration of bright sunshine hours. This implies that the increase in temperature, relative humidity, rainy days, rainfall and wind velocity also increase the fruit fly population and *vice-versa*. Furthermore, the increase in bright sunshine hours reduce the population of *B. dorsalis* and *vice-versa*. However, the population of *B. dorsalis* is not influenced by the morning relative humidity.

4. CONCLUSION

The *B. dorsalis* population prevailed throughout the year but the peak activity occurred during April to July which coincided with the maturity and harvesting period of the mango fruit. There was a significant positive correlation of population of *B. dorsalis* with maximum temperature, minimum temperature, average temperature, evening relative humidity, average relative humidity, rainy days, rainfall and wind velocity but a significant negative correlation with duration of bright sunshine hours. The knowledge on population dynamics of *B. dorsalis* help in making decision regarding the timing of application of appropriate management practices.

REFERENCES

Amol S, Nandre, Shukla A. 2014. Population dynamics of fruit fly [*Bactrocera dorsalis* (Hendle)] on sapota. Agricultural Science Digest 34(1): 70-72.

Anonymous. 2007. Survey of fruit fly in sapota. Annual Report. 3rd Plant Protection Sub Committee Meeting, Fruit Research Station, Navsari Agricultural University, Gandevi, Gujarat, 7-8 p.

Badii K B, Billah M K, Nuamah K A, Ofori D O, Nyarko G. 2015. Review of the pest status, economic impact and management of fruit infesting flies (Diptera: Tephritidae) in Africa. African Journal of Agricultural Research 10: 1488-1498.

Bana J K, Sharma H, Kumar S, Singh P. 2017. Impact of weather parameters on population dynamics of oriental fruit fly, *Bactrocera dorsalis* (Hendle) (Diptera: Tephritidae) under south Gujarat mango ecosystem. Journal of Agrometeorology 19(1): 78-80.

Bansode G M, Patel Z P. 2018. Effect of weather parameters on population fluctuation of mango fruit flies, *Bactrocera* spp. International Journal of Chemical Studies 6(5): 27-30.

Bansode G M, Patel Z P. 2020. Effect of weather parameters on population fluctuation of guava fruit flies, *Bactrocera* spp. International Journal of Chemical Studies 8(5): 1445-1448.

Choudhary J S, Kumari A, Das B, Maurya S, Kumar S. 2012. Diversity and population dynamic of fruit flies species in methyl eugenol based Para pheromone traps in Jharkhand region of India. Proceedings of International Conference on Anthropogenic Impact on Environment & Conservation Strategy (ICAIECS-2012) November 02-04, 2012, Ranchi, Department of Zoology, Ranchi University, Ranchi & Departments of Zoology and Botany, St. Xavier's College, Ranchi in association with National Environmentalist Association, India: 57-60 p.

Dale N S. 2002. Studies on the biology of *Bactrocera zonata* (Saunders) and management of fruit flies in mango orchards. M.Sc. (Agri.) Thesis submitted to Gujarat Agriculture University, S. K. Nagar. (Unpublished).

Drew R A I, Raghu S. 2002. The fruit fly fauna (Diptera: Tephritidae: Dacinae) of the rain forest habitat of the Western Ghats, India. The Raffles Bulletin on Zoology 50(2): 327- 352.

Ekesi S, Chabi-Olaye A, Subramanian S, Borgemeister C. 2011. Horticultural pest management and the African economy: successes, challenges and opportunities in a changing global environment. Acta Horticulturae 911(911): 165-183.

Indian Horticulture Database (2019-20). Area and production of horticulture crops. First Advance Estimates. 3 p.

Jena M K, Patel S R, Bairwa K L, Sahoo S. 2022a. The Melon Fruit Fly, *Bactrocera cucurbitae*: A Menace to Horticultural Crops. Current Research in Agricultural Entomology (Volume-2). Bright Sky Publishers, New Delhi, India, pp. 49-74.

Jena M K, Patel S R, Sahoo S. 2022b. Fruit Fly: A Destructive Pest of Horticultural Crops and Its Management Strategies. Applied Entomology and Zoology (Volume-8). Akinik Publishers, New Delhi, India, pp. 149-176.

Jena M K, Patel S R, Swaroopa K, Sahoo S. 2022c. Ber Fruit Fly, *Carpomyia vesuviana* Costa and its Management Strategies. Latest Trends in Agricultural Entomology (Volume-4). Integrated Publishers, New Delhi, India, pp. 27-45.

Kumar S, Patel C B, Bhatt R I. 1997. Studies on seasonal cyclicity of *Bactrocera correcta* Bezzi in mango and sapota orchards using methyl eugenol trap. Gujarat Agricultural University Research Journal 22: 68-74.

Lakshminarayana S. 1980. Tropical and subtropical fruits; composition, properties and use: In mango. (Editions) Nagy, S. and Shaw, P. E. AVI publishing, Westport, Connecticut, pp. 184-257.

Majumdar P K, Sharma D K. 1990. Mango. In: Bose, T. K. and Mitra, S. K. (editions), Fruits: Tropical and Subtropical. Naya Prakash, pp. 1-62.

Mishra J, Singh S, Tripathi A, Chaubi M N. 2012. Population dynamics of oriental fruit fly, *Bactrocera dorsalis* (Hendle) in relation to abiotic factors. Horticulture Flora Research Spectrum 1(2): 187-189.

Mohamed S, Ekesi S, Khamis F. 2012. Biology and management of fruit flies in Africa, their risk of invasion and potential impact in the near east risk of invasion and potential impact in the near east. Regional symposium on the management of fruit flies in the Near East countries, Hammamet, Tunisia, 6-8 November, p. 1-34.

Mumford J D. 2001. Project memorandum on integrated management of fruit flies in India. Department for International Development (DFID), 6 p.

Nandre A S, Shukla A. 2014. Population dynamics of fruit fly, *Bactrocera dorsalis* (Hendle) on sapota. Agricultural Science Digest 34(1): 70-72.

Patel D R, Patel J J, Muchhadiya D V, Patel R B. 2019. Influence of weather parameters on mango fruit fly, *Bactrocera dorsalis* Hendle. Journal of Entomology and Zoology Studies 7(4): 1157-1160.

Patel K B, Saxena S P, Patel K M. 2013. Fluctuation of fruit fly oriented damage in Mango in relation to major abiotic factors. HortFlora Research Spectrum 2(3): 197-200.

Pena J E, Mohyuddin A I, Wysoki M. 1998. A review of the pest management situation in mango agro ecosystem. Phytopara 26: 1-20.

Prokopy R J. 1977. Stimuli influencing trophic relations in Tephritidae. In: Comporement des Insects Millieu Trophique. Labeyrie. Coll. Int. Centre National de la Recherche Scientifique 265: 305-336.

Scherrer J. 2007. The most popular fruit in the world. Retrieved from http://www.banderasnews.com/0712/rr-mangomango.html). [Accesssed 30 Jan, 2015].

Sharma D R. 2011. Comparison of the trapping efficacy of different types of methyl eugenol based traps against fruit flies, *Bactrocera* spp. infesting Kinnow mandarin in the Indian Punjab. Journal of Insect Science 24: 109-114.

Singh S K. 2010. Biology of *Bactrocera* (*Zeugodacus*) *tau* (Walker) (Diptera: Tephritidae). Entomological Research 40: 259-263.

Stonehouse M, Mahmood A, Poswal K, Mumforda N, Baloch M, Chaudhary H, Makhdum G, Huggett D. 2002. Farm field assessments of fruit flies (Diptera: Tephritidae) in Pakistan: distribution, damage and control. Crop protection 21(1): 661-669.

Tandon P L, Verghese A. 1985. World list of insect, mite and other pests of mango. Technical Document, No. 5, IIHR, Banglore 6(3): 122-131.

Verghese A, Nagaraju D K, Madhura H S, Jayanthi P D K, Devi K S. 2006. Wind speed as an independent variables to forecast the trap catch of the fruit fly (*Bactrocera dorsalis*). Indian Journal of Agricultural Science 76(3): 172-175.

Wei D, Dou W, Jiang M, Wang J. 2017. Oriental fruit fly *Bactrocera dorsalis* (Hendel). Biological invasions and its management in China, pp. 267-283.

White I M, Harris E M M. 1992. Fruit flies of Economic Significance: Their Identification and Bionomics. CAB International, Wallingford, UK.