Seasonal Incidence and Effect of Abiotic Factors on Mango Leaf Hopper(*Amritodus atkinsoni* L.) Population on Different Cultivars of Mango in EasternUttar Pradesh

ABSTRACT

The mango hopper (*Amritodus atkinsoni L.*) is a very serious pest of mango in Eastren Uttar Pradesh. A series of experiments wereconducted on seasonal abundance and the influence of abiotic factors on the incidence of *A. atkinsoni* on different cultivars of mango *viz*. Dasheri, Sindhu, Amarpali and Langra at Vindhyavasini Park (Mango orchard) in DDU, Gorakhpur University Gorakhpur.The mango hoppers (adults) started appearing with the panicle emergence during the 40^{th} to 20^{th} SW (2022-2023). The peak population of mango hopper was seen onDasheri varietyin14^{th} SW and minimum in 42^{th} SW followed by Amrapalivariety, maximum incidence of mango hopper was seen on 4^{th}, 7^{th}, 8^{th} SW and minimum in 40^{th} SW. Abiotic factors such as maximum temperature(X_1), minimum temperature(X_2), morning relative humidity(X_3), evening relative humidity(X_4), and rainfall (X_5) had much impact on the impact of hopper population.The hopper population negatively correlated andsignificantly with morning relative humidity (r = -0.65** to 0.34*) and evening relative humidity (r = -0.40* to -0.21)and showed asignificant negatively correlation with mean maximum temperature (r = 0.28 to 0.09) and minimum temperature (r = 0.17 to – 0.02), whereas rainfall remained fluctuating throughout the study period thus didn't show any significant impact.

Keywords: Mango hopper, seasonal incidence, abiotic factor, multiple correlation coefficients.

INTRODUCTION

Mango (*Mangifera indica* Linn., family., Anacardiacae) is the most important commercially popular fruit and is also the national fruit of India. It is referred to as the "king of fruits" due to its wide adaptability, sweetness, excellent flavor, and delicious taste, as well as its rich source of nutrition, mineral fiber, vitamin A, C, and pro-vitamins [10]. India is one of the world's main mango producers in world. In India, it is cultivated in accounting for fifty percent of the global total, and ranks third in mango exports. India has the greatest land area among these nations [5].

With a land area of 2,339 million hectares and a crop yield of 2,036,600 metric tons, India is the world's foremost agricultural producer. In India it is cultivated in Uttar Pradesh, Karnataka, Bihar, Gujarat, Tamil Nadu, and Maharashtra. Uttar Pradesh is the leading producer state, with a total output of 4,807,83 MT [2].On a global scale, 26 species of nematodes and 462 species of insects that assault mango have been identified. [9] have reported a number of insect predators, including hoppers, viz., *Idioscopus clypealis* (Lethierry), *Amritodus atkinsoni* (Lethierry); mealybugs, *Drosicha mangiferae* (Green); fruit flies, *Bactrocera dorsalis* (Hendel); fruit sucking moth, *Eudocima aurantia* (Moore); thrips, *Aeolothrips itermedius* Bagnall; ants, *Oecophylla smaragdina* (Fabricius); termites, *Odontotermes spp*. and grey weevil, *Myllocerus discolour* (Boheman) which affect mango tree. Due to climate change and better conditions, mango hoppers like *A. atkinsoni*., *I. clypealis* and *Idioscopus nitidulus* (Walker) are becoming more dangerous during the mango's blooming season.[12] observed that the mango hopper,*Idioscopus* spp. was most common during the 49th standard weeks and went away on the 13th SW. [21] noticed that adult mango hoppers start to show up when the panicles start to grow in between February and March. The number of adult mango hoppers ranges from 9.6 to 14.2 in the wild and in all cultivars during May and June. The number of hoppers started to go down over time, but there was another peak (6.6 to 9.8) in August and September. [20] Reported that the number of mango hoppers started to rise gradually from the second week of September to the fourth week of September (18.22 hoppers per 5 panicles), which was between 37 and 39 metrological weeks. The most mango hoppers were found in the 44th metrological week, when there were 45.76 hoppers per 5 panicles.[14]revealed that the highest temperature (r = 0.093) had a positive correlation with the number of hoppers, while the minimum temperature (r = -0.217) had a negative correlation. [20] found that the temperature (r = 0.302) had a positive relationship with the number of mango hoppers, while rain (r = -0.062) and relative humidity (r = -0.383) had a negative relationship. [1] observed that relative humidity hurts hopper populations. [4] did an experiment to see how the population of the mango hopper, *A. atkinsoni*, changed over time based on yearly abundance and where people gathered on the mango cultivar Langra during the Rabi season. The most common mango hoppers are found on the main branch in May, followed by leaves and flowers. The mango hoppers has a strong and positive relationship with the temperature and a strong and negative relationship with the relative humidity in the morning (r =

-0.445) and the relative humidity in the evening (r = -0.118). Rainy days and rain don't have much of an effect on the number of mango hoppers [6].

MATERIALS AND METHODS

The present experiment on Seasonal incidence and effect of abiotic factors on mango hopper (*Amritodus atkinsoni* L.) population on different cultivars of mango in Eastern Uttar Pradesh was carried out during 2022-2023 at Vindhyavasini Park (Mango Orchard) in DDU, Gorakhpur University, Gorakhpur on 20-25 years old mango tress. The geographical coordinates of Gorakhpur are 26.766^{o} latitude, 83.369^{o} longitude, and 272 Ft. elevation.The seasonal incidence of *A. atkinsoni* population in relation to abiotic factors temperature (X_1) minimum temperature (X_2) morning relative humidity(X_3), evening relative humidity(X_4) and rainfall (X_5) were conducted on four each of cultivars Dasheri, Amarpali, Sindhu and Langra.An experiment was conducted to the seasonal incidence of mango hopper, *A. atkinsoni* (adults) at weekly interval from three (3) randomly selected trees, *i.e*., one tree per replication. During this investigation all agronomic practices was followed from time to time excluding plant protection measures. The observations on hopper population was recorded throughout the year at bloom and vegetative phases viz., at panicle emergence stage or pre bloom, at bloom period, at fruit stage, and non-flowering seasons from July to December. Hopper population was collected form panicles, leaves, stem and trunk through bagging traps method as suggested by [23]. In this method the terminal part of inflorescence was covered with a polythene bag (60 ×30 cm^2), provided with cotton swabbed soaked in ethyl acetate. After the trapping the mango hoppers, bags were brought to laboratory and both nymphs and adults were separated and counted. Same method was used for collection of hopper from new flush, branches and stems of mango trees. Data on mango hopper was recorded from trunk per 10 cm^2 area of tree in four (North, South, East and West) directions.Simultaneously, observations on meteorological factors i.e maximum and minimum temperature, relative humidity (both morning and evening) and rainfall were recorded daily. Fortnightly average was calculated for all these factors before calculating Pearson's correlation coefficient and multiple correlation coefficients.

RESULTS AND DISCUSSION

The periodical data on seasonal incidence of mango hoppers recorded from mango panicles/inflorescences were also correlated with various abiotic factors to determine the relationship with pest.The incidence of mango hoppers was recorded on mango crop starting from 40^{th} to 20^{th} SWperiodically at weekly interval.

Seasonal incidence of mango hopper *A. atkinsoni* in variety Dashehri (mango)

It was observed (Table 1) that in the 40^{th} SW of 10.33 hopper /panicle population were seen on the mango tree (Dasheri variety) during the period respectively, the mean maximum temperature (31.20^{o}C) and minimum temperature (20.10^{o}C), while the relative humidity was recorded at morning 88.25 and evening 46.52 %. During the season hopper population was observed in the 40^{th} -20^{th} SW in the year of 2022-2023. The maximum population of mango hopper was observed in 14^{th} SW (27.00 hopper/panicle) when maximum temperature was 33.12^{o}C and minimum temperature was 17.23^{o}C and relative humidity morning (72%) and evening (28%), followed by 16^{th} SW (25.67 hopper/panicle) and 12^{th} SW(25.00hopper/panicle). However, the minimum population of mango hopper was observed in 42^{th} SW(7.00 hopper/panicle), followed by in 49^{th} SW (9.00hopper/panicle) and 44^{th} SW (9.67hopper/panicle) on mango tree.

The data on correlation coefficient between weather parameters and hopper population revealed that the hopper population was positive correlation coefficient (r = 0.28 and r = 0.17) between the maximum and minimum temperature and also significant in the year. The population showed negative correlation coefficient with highly significant with relative humidity morning (r = -0.65**) and relative humidity evening was negative correlation coefficient with significant (r = -0.40*), while rainfall showed positive correlation coefficient with significant (r = 0.147*) (Table 2).

Following regression equation was developed to predict the incidence of hopper

Y= 101.39 - 0.367X1+0.074X2-0.875X3-0.066X4-2.824X5

The regression equation revealed that the various abiotic factors were to be most influencing factor, which contributed (R^2= 0.549) 54 per cent variation in hopper population with abiotic factors [11], who saw an enormous decrease in the number of hoppers from April to May at Jhansi (U.P.), also agreed with the results of this study. [22], [17], noticed that *A. atkinsoni* adults started showing up in February and March shows that the correlation values between abiotic factors and mango hopper were not significant. They found a positive correlation with the highest temperature (r = 0.3406) and a negative correlation with the lowest temperature (r = -

0.2038). Also found a weak positive correlation between the number of hoppers and the RH in the morning and a strong negative correlation between the RH in the evening at Tirupati. Both [24] found that the number of hoppers went down when relative humidity and minimum temperature went up. This is because hoppers mostly show up when flowers bloom and new shoots start to grow, which is when the crop's phenology and abiotic factors come together. Abiotic factors may not have had much of a relationship because there were no hoppers around during the other months of the static crop time. In general, the number of hoppers changes with the growth of crops in different areas, and the weather isn't the same every year, which can change how important they are. So, the most important data of weather conditions and hopper populations over a number of years in a controlled canopy is going to result in predictions that are more precise.

Seasonal incidence of mango hopper *A. atkinsoni* in variety ofAmrapali (mango)

It was observed (Table 1) that in the 7^{th} ,4^{th} and 8^{th} SW of 31.33hopper/panicle population were seen maximum population of mango hopper on mango tree (Amrapali), followed by 20^{th} and 11^{th} SW (30.67 hopper/panicle). Respectively, the minimum population of mango hopper was 40^{th} ,42^{th} and 41^{th} SW (13.33 hooper/panicle, 14.67 hopper/panicle and 16.33hopper/panicle). The mean were 7^{th} and 8^{th} SW maximum temperature (25.77^{o}C and 27.47^{o}C) and minimum temperature (12.00^{o}C and 12.08^{o}C), while the relative humidity 7^{th} and 8^{th} SW was recorded at morning 77.42 and 86.00i;e evening at recorded 39.14 and 42.42 %. In SW 1^{st} , 2^{nd} and 3^{rd} observed that 20.33hopper/panicle , 23.33 hopper/panicle and 26.33hopper/panicle and 1^{st} , 2^{nd} and 3^{rd} SW maximum temperature was 18.57 ^{0}C , 12.27^{0}C and 16.8^{0}C

The data on correlation coefficient between weather parameters and hopper population was revealed that the correlation between maximum temperature was positive and minimum temperature was negative hopper population (r = 0.10 and r = -0.11) and non-significant in the year. The correlation between morning and evening relative humidity was negative (r = -0.50** and r = -0.34*) significant in the year.The correlation between rain fall and hopper population was positive (r = 0.30*) and significant in the year(Table 2).

Following regression equation was developed to predict the incidence of hopper

Y=82.32-0.354X1-0.558X2-0.332X3-0.279X4+0.839X5

The regression equation revealed that the various abiotic factors were to be most influencing factor, which contributed (R^2= 0.529) 52 per cent variation in hopper population.

According to [13], the population of mango hoppers began to increase in January and reached its peak in May. Due to the formation of inflorescence and fruiting stages, [3] identified two peak occurrences of mango hoppers in South Gujarat, with the highest activity between the last week of March and the last week of May. From the second week of September to the fourth week of September, mango hoppers progressively increased, corresponding to the 37th and 39th SW. In addition, [25] reported that hopper activity decreased from April onwards, reached its lowest point (0.20 and 0.33 hopper/panicle) during the 34th SW of 2016-17 and 2017-18, and then increased. [25] reported that from September 2013 to August 2014 and September 2014 to August 2015 evapotranspiration (r=0.443** and 0.368**), bright sunshine hours/day (r=0.398** and 0.325*) and maximum temperature (r=0.467** and 0.316*)showed positive correlation whereas, morning (r=-0.469** and -0.275*) and evening (r=-0.430** and -0.289*) relative humidity showed negative correlation with population of hoppers. According to [3], the population of mango hoppers had a significant positive correlation with maximum temperature (r=0.323*) and a significant negative correlation with morning (r=-0.496**) and evening (r=-0.824**) relative humidity (RH) and precipitation (r=-0.566**). [20] found that temperature (r=0.302), rainfall (r=-0.062), and relative humidity (r=-0.383) were positively correlated with the incidence of mango hoppers. According to [4], evaporation (r=0.890**), bright sunshine hours/day (r=0.370*), and maximum temperature (r=0.880**) demonstrated a significant positive correlation, whereas morning (r=-0.880**) and evening (r=-0.720**) RH demonstrated a significant negative association with hopper population. Population of mango hoppers had a positive correlation with maximum temperature (r=0.532** and 0.426**), sunshine hours/day (r=0.521** and 0.371**), and evaporation (r=0.379** and 0.375) from 2009-2010 to 2010-2011, while evening relative humidity (r=-0.304*) and precipitation (r=-0.281*) exhibited a negative correlation in 2009-10. In addition,[19] discovered that evaporation (r=0.743** and 0.527**) and maximum temperature (r=0.679** and 0.702**) during 2007-08 and 2008-09 as well as bright sunlight hours/day (r=0.435*) during 2008-09 were positively correlated with mango hopper population. Consequently, these studies closely align with the findings of the present investigation.

Seasonal incidence of mango hopper *A. atkinsoni* in variety ofSindhu (mango)

It was observed (Table 1) that in the 11th and 20th SW of 31.33hopper/panicle and 31.33/panicle hopper population were seen maximum population on the mango tree (Sindhu), followed by 4th , 6th and 16th SW (30.33 hopper/panicle), and minimum population was 41th and 40th SW (13.33hopper/panicle and 15.33 hopper/panicle) respectively, the mean of 11th and 20th SW maximum temperature (31.80°C and 36.25°C) and minimum temperature (16.91°C and 24.52°C), while the relative humidity 7th and 8th SW was recorded at morning 75.57 and 71.25 % i;e evening at recorded 31.42 and 26.50 %. In 18th, 19th and 20th SW seen mango hopper population 27.67hopper/panicle,25.67hopper/panicle and 31.33 hopper/panicle and in this SW maximum temperature 37.27°C, 38.51°C and 36.25°C.

The data on correlation coefficient between weather parameters and hopper population revealed that the correlation between maximum temperature and minimum temperature was positive correlation coefficient (r = 0.19 and r = 0.02) and non-significant in the year. The correlation between morning and evening relative humidity was negative (r = -0.48**and r = -0.34*) significant in the year(Table 4.).The correlation between rain fall and hopper population was positive (r = 0.23*) and significant.

Following regression equation was developed to predict the incidence of hopper

Y=82.17-0.56X1-0.177X2-0.301X3-0.341X4-0.18X5

The regression equation revealed that the various abiotic factors were to be most influencing factor, which contributed (R^2= 0.376) 37 per cent variation in hopper population.

In accordance with the findings of [12], the maximal incidence of mango hopper *Idioscopus* spp. occurred during the 49th standard week, and the insect pest disappeared on the 13th SW. While, [21] observed the appearance of mango hoppers (adults) beginning with the panicle emergence stage in February and March, with a peak of 9.6 to 14.2 in wild and all cultivars during May and June. Adult hoppers during inactive stages of plant growth remained alive without feeding in the cracks and crevices of the trunk, and heavy shower monsoons exceeding 100 mm in a straight line had a washing effect on the hopper population [14].

The present study supports with [7], who found a significant positive correlation between atmospheric temperature (r = 0.69), maximum temperature (r = 0.32), and minimum temperature (r = 0.40), and a significant negative correlation between morning relative humidity (r = -0.75) and evening relative humidity (r = -0.40). There was a negative but insignificant correlation between total rainfall and hopper population. [8] and [18] also reported that temperature had a

positive and significant impact on mango hopper population, while relative humidity had a negative and significant effect.

Seasonal incidence of mango hopper *A. atkinsoni* in variety ofLangra (mango)

It was observed (Table 1) that in the 6th SW of 32.33hopper/panicle hopper population were seen maximum population on the mango tree (Amrapali),followed by 16th and 4th SW (31.67 hopper/panicle and 31.33 hopper/panicle) and minimum population seen on SW 40th and 4th (11.67 hopper/panicle and 12.33 hopper/panicle) Respectively, the mean of SW 6th maximum temperature (23.01^{o}C) and minimum temperature (12.21^{o}C), while the relative humidity 6th and week was recorded at morning 86.57 and evening at recorded 54.58. In 40th, 41th and 42th SW population of mango hopper was 11.67 hopper/panicle, 12.33hopper/panicle and 15.67hopper/panicle.

The data on correlation coefficient between the correlation between maximum temperature was positive and minimum temperature was negative hopper population (r = 0.09 and r = -0.02) and non-significant in year. The correlation between morning and evening relative humidity was negative (r = -0.34**and r = -0.21) and highly significant in the year(Table .4).The correlation between rain fall and hopper population was positive (r = 0.11*) and significant .

Following regression equation was developed to predict the incidence of hopper

Y=67.54-0.162X1-0.268X2-0.368X3-0.099X4-0.0583X5

The regression equation revealed that the various abiotic factors were to be most influencing factor, which contributed (R^2= 0.432) 43 per cent variation in hopper population.

[16] studied insect population abundance in agroforestry systems in Mizoram, India, from 2000 to 2002 and found that summer and winter seasons had substantially higher and lower abundances, respectively. [9] conducted field experiments in Andhra Pradesh, India, and reported that host plants and climatic parameters influenced the population dynamics and abundance of the mango hopper, *A. atkinsoni*. They also observed negative correlations between hopper incidence and minimum temperature, relative humidity, and evening precipitation, as well as positive correlations between hopper incidence and maximum temperature and morning relative humidity.

CONCLUSIONS

The mature individuals of *Amritodus atkinsoni* L. emerged when the panicle formed, and the highest population was observed during February and March when the mango tree was in full

bloom. The second highest population was observed in August-September across all four

SW	Hopper Population /Panicle/Week	Temperature (^{o}C)	Relative Humidity (%)	Rainfall (mm)

cultivars being studied. Subsequently, the insect relocated to the fissures and crevices of the tree trunk in order to hibernate. This suggests that the organism has two distinct periods for reproduction, resulting in two separate generations: one in the spring and one in the summer. The spring generation is more harmful or damaging compared to the summer generation. The mean maximum and lowest temperature exhibited a strong positive link with the expansion of the hopper population, while the relative humidity (both in the morning and evening) had a notable negative impact. The variable rainfall did not have any impact on the expansion of the hopper population due to its fluctuating nature.

Table 1:Seasonal incidence of mango hopper *A. atkinsoni* during the year 2022-2023

	Dasheri	Amrapali	Sindhu	Langra	Max.	Min.	Morning	Evening	
40	10.33	13.33	15.33	11.67	31.20	20.10	88.25	46.52	0
41	11.33	16.33	13.33	12.33	31.35	19.10	86.21	45.22	0
42	7.00	14.67	18.33	15.67	29.00	17.00	87.25	46.21	0
43	12.67	22.67	19.33	23.67	31.50	18.60	85.23	44.35	0
44	9.67	20.67	20.67	27.67	28.40	17.50	86.74	43.21	0
45	14.00	21.33	26.33	24.33	30.51	18.30	86.28	44.28	0
46	11.33	22.33	22.67	25.00	28.75	16.90	84.71	44.30	0
47	15.00	24.67	26.33	18.67	27.87	13.47	84.71	35.85	0
48	11.33	25.33	23.67	17.67	27.80	12.38	83.71	38.85	0
49	9.00	23.33	23.67	26.33	26.85	11.70	88.14	40.14	0
50	15.00	25.33	16.67	24.33	25.70	11.10	84.57	46.71	0
51	16.00	23.33	27.33	27.67	24.38	10.37	82.56	52.14	0
52	12.67	26.67	27.33	26.33	23.87	11.32	87.14	46.85	0
1	22.67	20.33	17.67	18.33	18.57	9.17	85.14	59.57	0
2	15.00	23.33	22.67	26.67	12.27	8.48	83.57	73.14	0
3	16.33	26.33	20.67	18.33	16.80	7.52	85.14	64.71	0
4	12.67	31.33	30.33	31.33	22.52	8.08	83.85	45.85	0
5	18.00	29.33	29.33	29.67	23.97	12.44	85.28	55.57	0
6	22.00	28.33	30.33	32.33	23.01	12.21	86.57	54.58	0
7	22.00	31.33	27.33	22.33	25.77	12.00	77.42	39.14	0
8	21.67	31.33	29.67	28.33	27.47	12.08	86.00	42.42	0
9	24.33	27.33	29.67	26.67	29.65	14.80	80.42	36.71	0
10	20.67	24.33	28.33	27.33	31.10	16.42	76.42	34.00	0
11	24.67	30.67	31.33	27.33	31.80	16.91	75.57	31.42	0
12	25.00	28.33	24.67	28.67	29.72	18.05	81.00	44.14	1.24
13	24.67	30.33	24.33	27.33	31.11	16.84	77.14	30.57	1.48
14	27.00	27.33	27.67	27.67	33.12	17.23	72.00	28.00	0
15	22.67	29.33	23.33	27.67	35.31	17.54	74.00	27.25	0
16	25.67	29.67	30.33	31.67	36.25	19.11	72.00	24.15	2.5
17	24.67	25.67	29.67	25.67	35.24	18.25	68.50	26.34	0
18	16.33	29.67	27.67	24.33	37.27	19.52	66.02	27.50	3
19	24.67	25.67	25.67	28.33	38.51	23.25	70.05	25.25	0
20	19.33	30.67	31.33	27.33	36.25	24.52	71.25	26.50	0

Table 2: Correlation coefficient and regression value of hopper population and weather parameters

Sr.No	Weathers Parameters	Varieties			
		Dasheri	Amrapali	Sindhu	Langra
1.	Maximum Temp (Tmax)	0.28	0.10	0.19	0.09
2.	Minimum Temp (Tmin)	0.17	-0.11	0.02	-0.02
3	Morning RH (RHmor)	-0.65**	-0.50**	-0.48**	0.34*
4.	Evening RH (RHeve)	-0 .40*	-0.34*	-0.39*	-0.21
5.	Rainfall (mm)	0.147*	0.30	0.23	0.11

Table 3: Multiple regressions between weather parameters and seasonal incidence of mango hopper during 2022-2023.

Sr. No	Varities	Regression Equation	R^2 Value	Predicted Value (%)
1.	Dasheri	Y= 101.39 -0.367X1+0.074X2-0.875X3-0.066X4-2.824X5	0.549	54%
2.	Amrapali	Y=82.32-0.354X1-0.558X2-0.332X3-0.279X4+0.839X5	0.529	52%
3.	Sindhu	Y=82.17-0.56X1-0.177X2-0.301X3-0.341X4-0.18X5	0.376	37%
4.	Langra	Y=67.54-0.162X1-0.268X2-0.368X3-0.099X4-0.0583X5	0.432	43%

Fig 1. Effect of abiotic factors on seasonal abundance of *Amritodus atkinsoni* (adults) on Dashehari

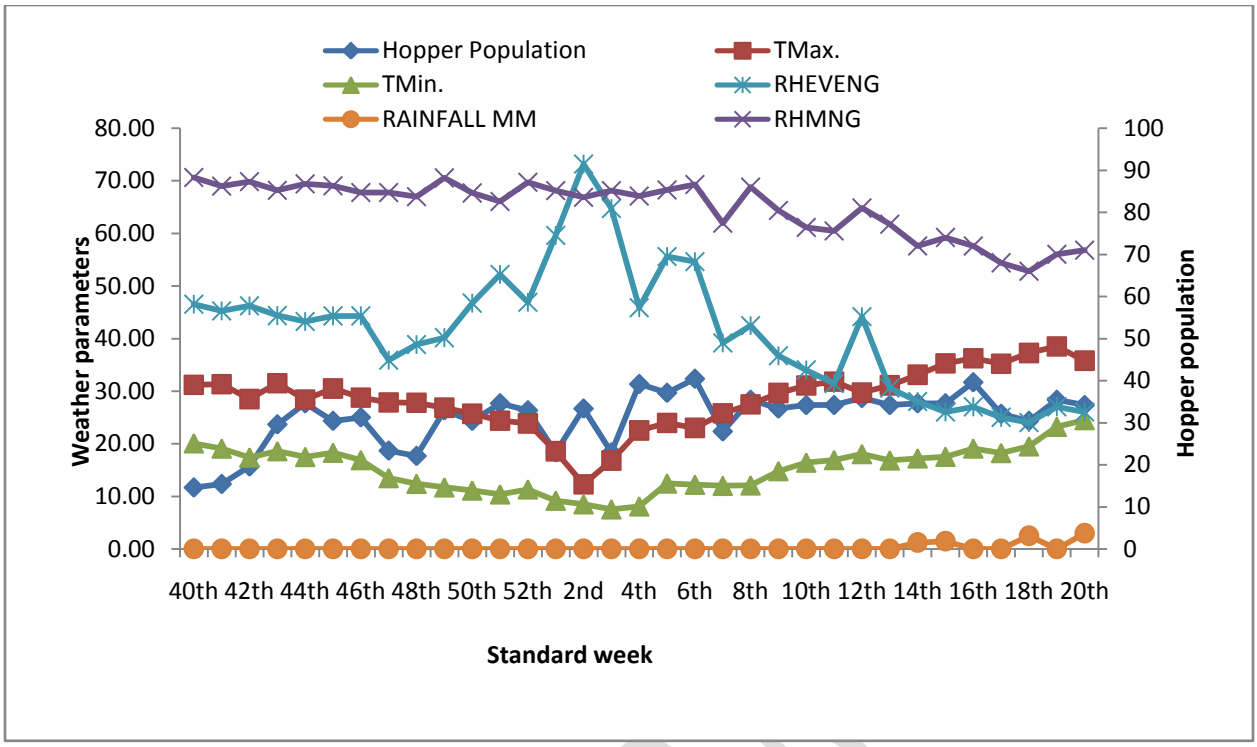


Fig 2. Effect of abiotic factors on seasonal abundance of *Amritodus atkinsoni* (adults) on Amrapali

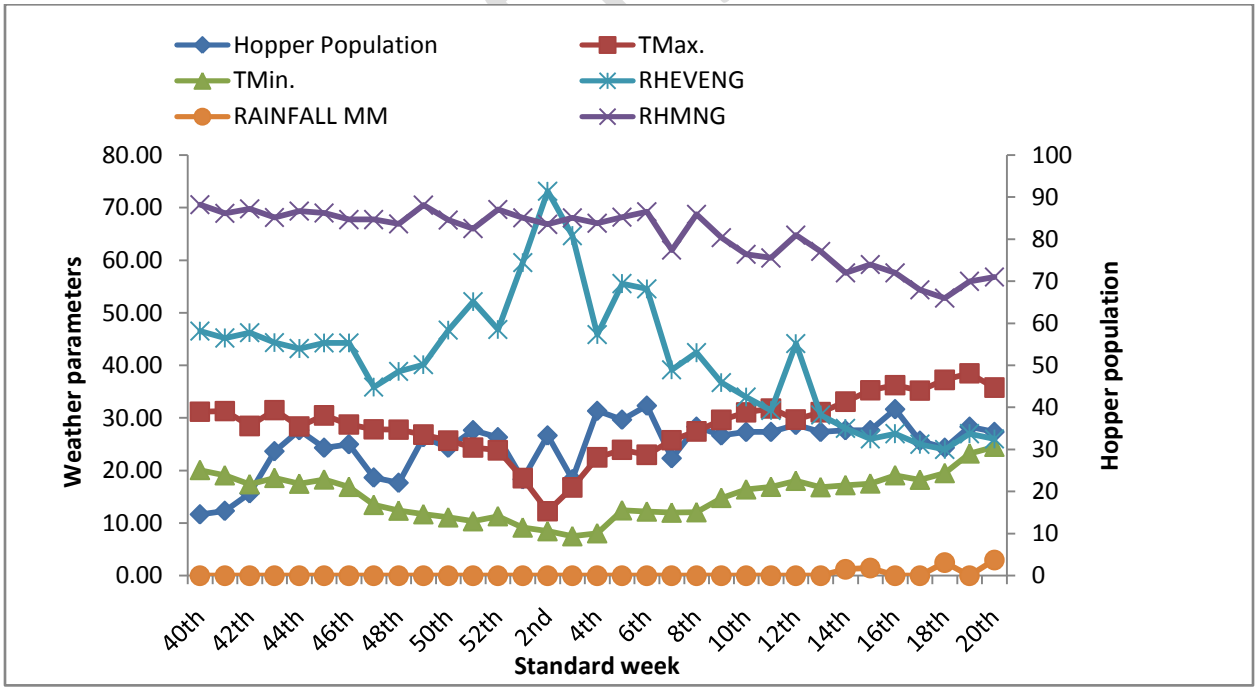


Fig 3. Effect of abiotic factors on seasonal abundance of *Amritodus atkinsoni* (adults) on Sindhu

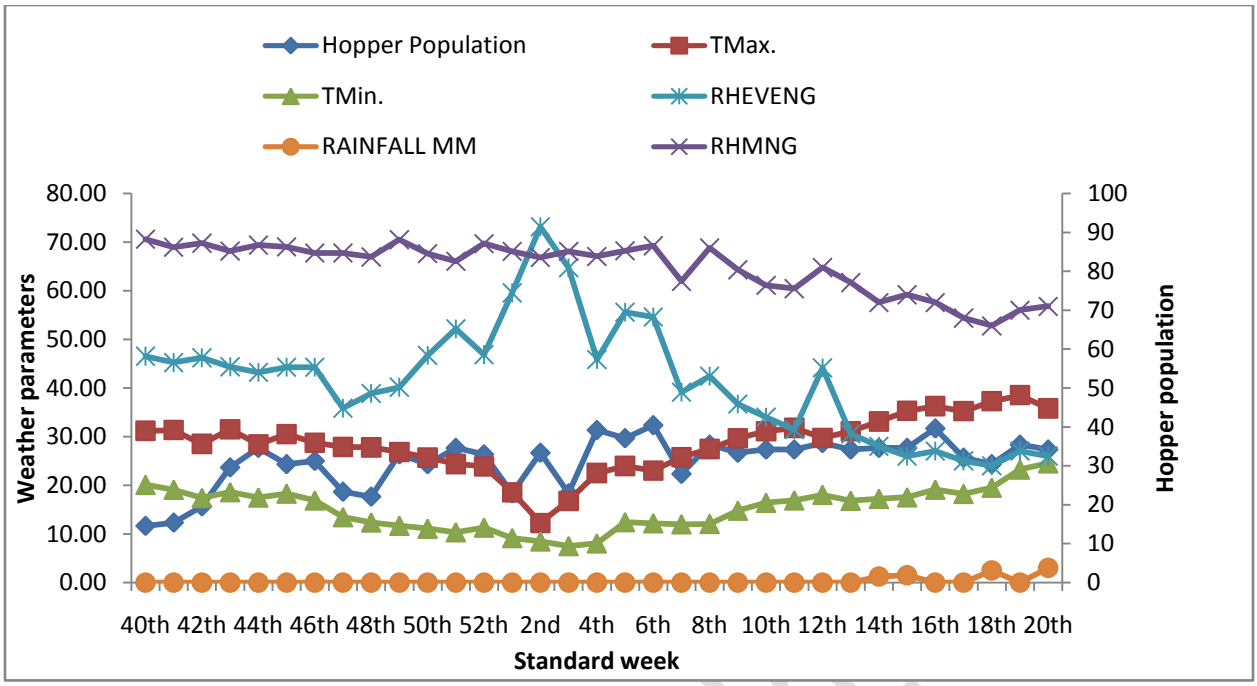
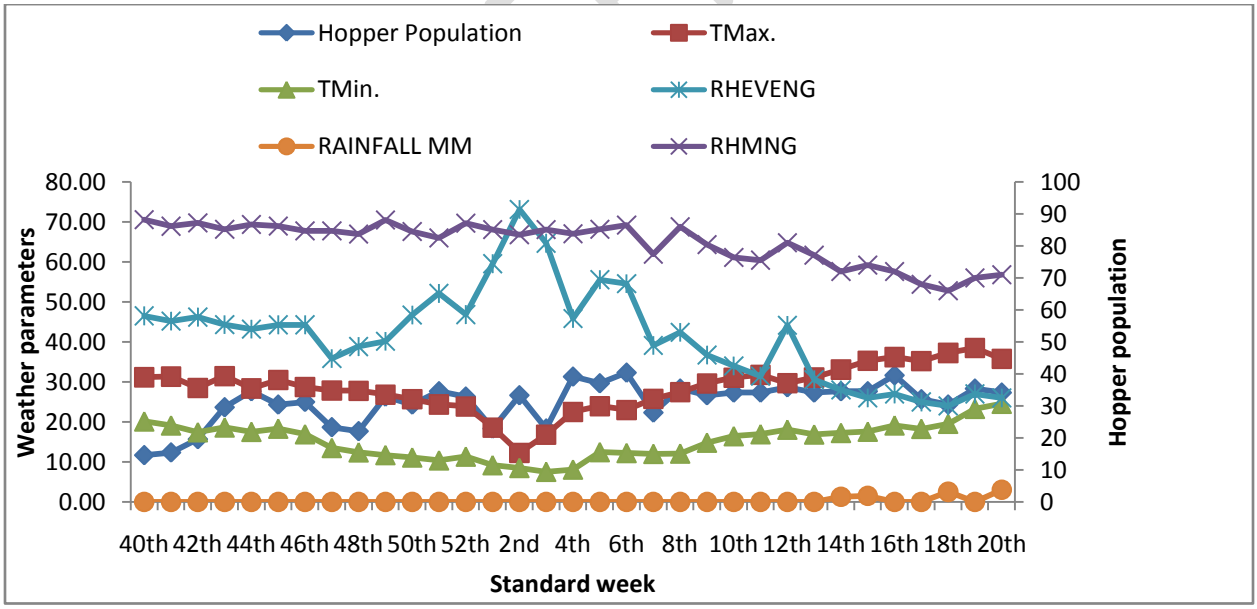


Fig 4. Effect of abiotic factors on seasonal abundance of *Amritodus atkinsoni* (adults) on Langra



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