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Population dynamics of rice leaf folder, *Cnaphalocrocis medinalis* Guenee (Pyralidae: Lepidoptera) on rice in relation to weather parameters

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Abstract
In a field experiment on study the population dynamics of rice leaf folder, *Cnaphalocrocis medinalis* on rice in relation to weather parameters during *Kharif* 2020 to 2021. Result revealed that the maximum number of larvae (11.22) were observed during third week of September (38th SMW), while minimum number of (0.88) larvae were observed during third week of October (42nd SMW). Per cent damaged leaves and weather parametres indicated that maximum per cent damaged leaves (20.19%) were observed in fourth week of September (39th SMW) and that of minimum per cent damaged leaves (0.98%) were noticed during fourth week of October (43rd SMW). Then after it was disappeared in next SMW. Thus, the findings refer that per cent damaged leaves caused by leaf folder was observed during 31st SMW to 43rd SMW while, number of larvae observed during 31st SMW to 42nd SMW. Highly significant negative association was found between maximum temperature (-0.6827) and sunshine hours (-0.6767) with number of larvae and highly significant negative correlation was found between maximum temperature (-0.6494) and sunshine hours (-0.6575) with per cent damaged leaves. Positive relationship of humidity was found with the number of larvae and per cent damaged leaves. Highly significant positive correlation was found between maximum relative humidity (0.6321) while significant positive correlation was found between minimum relative humidity (0.5471) with number of larvae and in case of per cent damaged leaves, maximum relative humidity (0.6469) was found highly significant positive while minimum relative humidity (0.5612) was found significant positive whereas, Minimum temperature had non-significant negative correlation while rainfall and rainy days were found non-significant positive correlation with the number of larvae and per cent damaged leaves.

Keywords: Rice, leaf folder, *Cnaphalocrocis medinalis*, population dynamics, weather parametres, correlation

Introduction
Rice (*Oryza sativa* Linnaeus) belongs to the family of grasses (Poaceae), which is one of the most important cereal crop worldwide. It is the staple food for more than two billion people in developing countries (Appala *et al*., 2018) [3]. Rice is grown over 120 million hectares to produce 600 million tonnes of grain with an average productivity of 5000 kg/ha (Jakarpong and Wiboon, 2017) [11]. In India, farmers grow many kinds of cereals, among them rice is grown in 43.86 million hectares, the production level is 112 million tonnes and the average productivity is about 2600 kg/ha. Rice is grown in almost all the states in the country. However the major five states in rice production are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Bihar, Chhatisgarh and Tamil Nadu (Anon., 2020) [2]. In India, Gujarat ranks 15th in terms of area and production and 9th in productivity (2011). Rice grown in the state during the year 2019-20 is 0.90 million hectare and production is 1.98 million MT (Anon, 2021) [1]. The insect-pest incidence is one of the major constraints for crop failure due to outbreaks of insect-pests have been reported worldwide (Reddy, 2013) [24]. Among various pests of rice, rice leaf folder is one of the most serious and most important pest of rice crop in Indian subcontinent (Shanmungam *et al*., 2006) [26]. Out of eight species, the most wide spread and important one is *C. medinalis* (Guenee) (Bhatti, 1995) [5]. It was earlier considered a minor pest but now a days it assumed major pest status. The shift in pest status is mainly attributed to changes in crop management practices, increased insecticides applications and weather parametres (Chakraborty and Deb, 2011) [7]. Temperature can impact insect physiology and development directly or indirectly through the physiology or existence of hosts. The important weather factors *viz*., temperature, relative humidity and rainfall with the pest population so as to estimate the role of weather and to make an effort to assess abundance of rice insect-pest

(Kafle *et al*., 2018) [14]. Bhanu and Reddy (2008) [4] who reported that in favorable conditions leaf folder affected crop adversely resulting in severe loss in India. The loss may extend up to 63 to 80 per cent depending on agro-ecological situations as reported by Rajendran *et al*. (1986) [23]. Inspite of its regular occurrence and importance of this pest in South Gujarat region, the information on its population dynamics is not available. Therefore, it is necessary to find out population dynamics of rice leaf folder and its relation to weather parametres.

Materials and methods

The field investigation on population dynamics of rice leaf folder was carried out at Main Rice Research Centre farm, Soil and Water Management Research Unit, Navsari Agricultural University, Navsari, Gujarat during *Kharif* 2020 and 2021. The population dynamics of rice leaf folders were recorded on rice variety GR-11 (State susceptible check). For this purpose, GR-11 was transplanted in 400 m^2 area. The observations were recorded on weekly interval in each standard meteorological week after transplanting of rice seedlings, starting from 7th DAT (Days after Transplanting) till harvest of the crop. The leaf folder damage was recorded from randomly selected 25 plants by the counting of total number of larvae/hill, total numbers of leaves/hill and the total number of damaged leaves/hill (only if one-third of leaf area is damaged), infested by rice leaf folder. Recorded data were converted in per cent leaf damage by using following formula given by Netam and Gupta (2015) [21].

$$\text{Leaf damage (\%)} = \frac{\text{Total number of damaged leaves}}{\text{Total number of leaves (Healthy + Damaged)}} \times 100$$

Leaf folder damage depends on influence of weather parameters. In order to study the influence of abiotic stress (weather parameters) *viz*., maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, rainfall, rainy days and sunshine hours on population of rice leaf folder, *C. medinalis*. Weekly meteorological data recorded from meteorological observatory, N. M. College of Agriculture, Navsari Agricultural University, Navsari were used for this purpose. Correlation coefficient was also worked out. All the post sowing recommended agronomical practices were followed. The experimental area was kept free from insecticide spray throughout the crop season in order to record incidence of rice leaf folder, *C. medinalis*.

Results and discussion

Population dynamics of rice leaf folder, *C. medinalis* on rice in relation to numbers of larvae

Data on population dynamics of rice leaf folder (*Kharif* 2020) presented in Table 1 and Fig 1 indicated that the larvae appeared three week after establishment of transplanted paddy seedlings *i.e.* from fifth week of July (31st SMW) and continued up to the third week of October (42nd SMW). The maximum number of larvae (10.80) were found in third week of September (38th SMW). The minimum number of larvae (0.72) were found in fifth week of July (31st SMW). The number of larvae started declining after third week of September. The data pertaining to number of larvae were ranged from 0.72 to 10.80 during *Kharif* 2020. During *Kharif* 2021, the similar trend on number of larvae were observed but in higher numbers observed than *Kharif* 2020. During *Kharif* 2021, the number of larvae started appeared during fifth week of July (31st SMW) and continued up to the third week of October (42nd SMW). The maximum number of larvae (11.64) were noticed in third week of September (38th SMW). Data on number of larvae ranged from 0.80 to 11.64. Whereas, minimum numbers of larvae were noticed 0.80 in third week of October (42nd SMW) (Table 1 and Fig. 1). Overall in pooled (Table 1 and Fig. 3), the result indicated that data on number of larvae were similar as observed in both the years (2020-2021). Maximum number of larvae (11.22) were observed in third week of September (38th SMW). Minimum number of larvae (0.88) were observed during third week of October (42nd SMW). Then after number of larvae were disappeared up to the harvesting of the crop.

Table 1: Population dynamics of rice leaf folder, *C. medinalis* in relation to weather parameters

SMW	Standard Period	WATP	Number of larvae			% damaged leaves		
			2020	2021	Pooled	2020	2021	Pooled
28	9-15 July	1	0.00	0.00	0.00	0.00	0.00	0.00
29	16-22 July	2	0.00	0.00	0.00	0.00	0.00	0.00
30	23-29 July	3	0.00	0.00	0.00	0.00	0.00	0.00
31	30 July-5Aug.	4	0.72	1.12	0.92	2.54	3.69	3.12
32	6-12 Aug.	5	2.12	0.00	1.06	7.65	6.47	7.06
33	13-19 Aug.	6	2.00	5.36	3.68	8.39	9.63	9.01
34	20-26 Aug.	7	5.60	8.36	6.98	10.79	11.80	11.30
35	27Aug.-2 Sep.	8	7.00	7.20	7.10	13.88	14.31	14.10
36	3-9 Sep.	9	8.12	9.36	8.74	15.98	17.88	16.93
37	10-16 Sep.	10	9.52	10.00	9.76	17.11	18.80	17.96
38	17-23 Sep.	11	10.80	11.64	11.22	18.98	19.93	19.46
39	24-30 Sep.	12	7.60	10.16	8.88	19.87	20.50	20.19
40	1-7 Oct.	13	4.32	5.88	5.10	13.69	14.86	14.28
41	8-14 Oct.	14	2.32	3.20	2.76	8.37	10.37	9.37
42	15-21 Oct.	15	0.96	0.80	0.88	3.46	6.37	4.92
43	22-28 Oct.	16	0.00	0.00	0.00	0.73	1.23	0.98
44	29 Oct.-4 Nov.	17	0.00	0.00	0.00	0.00	0.00	0.00

WATP: Week after Transplanting, **SMW:** Standard meteorological week

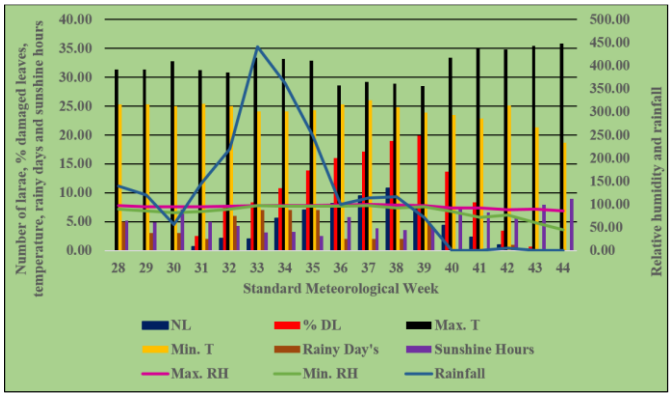

Fig 1: Population dynamics of rice leaf folder, *C. medinalis* in relation to weather parameters during *Kharif*-2020

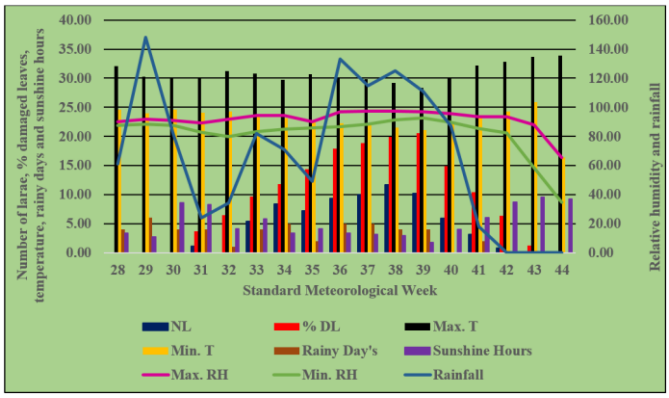

Fig 2: Population dynamics of rice leaf folder, *C. medinalis* in relation to weather parameters during *Kharif*-2021

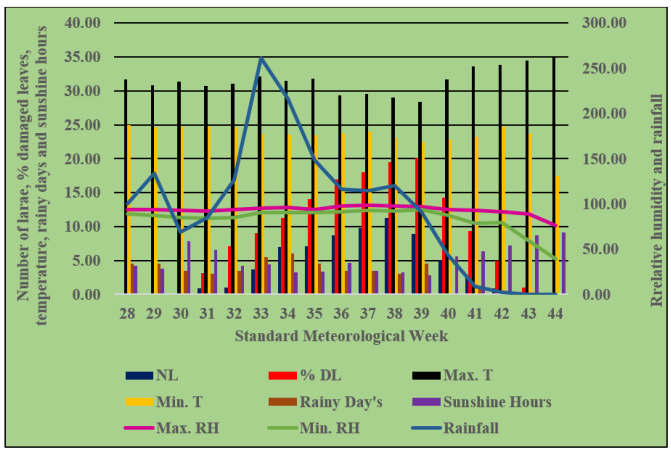

Fig 3: Population dynamics of rice leaf folder, *C. medinalis* in relation to weather parameters (Pooled)

Population dynamics of rice leaf folder, *C. medinalis* on rice in relation to per cent damaged leaves

The data on per cent damaged leaves by leaf folder, *C. medinalis* during *Kharif* 2020, 2021 and pooled are presented in Table 1 and Fig. 1 to 3. It is revealed that the per cent damaged leaves was found significant during *Kharif* 2020, *Kharif* 2021 and also in pooled. During *Kharif* 2020, infestation started from fifth week of July (31st SMW) or 21 days after transplanting (DATP) and continued up to the fourth week of October (43rd SMW). The maximum infestation (19.87% DL) was found in fourth week of September (39th SMW). The per cent infestation started declining after fourth week of September (39th SMW) thereafter continuously up to the harvest of the crop. The minimum per cent infestation (0.73% DL) was recorded in fourth week of October (43th SMW). The data recorded on per cent damaged leaves indicated that infestation was ranged from 0.73 to 19.87 per cent damaged leaves. During *Kharif* 2021, the similar trend of infestation was observed but in higher rate than it was observed in *Kharif* 2020. The infestation commenced from fifth week of July (31st SMW) and continued up to the fourth week of October (43rd SMW). The maximum infestation (20.50% DL) was found in fourth week of September (39th SMW) thereafter started decreasing up to fifth week of October (43th SMW) noticed minimum per cent damaged leaves was 1.23 per cent in fourth week of October (43rd SMW) and disappeared in next SMW. Results on pooled data (*Kharif* 2020 and 2021), showed that the infestation trend was similar as observed in both the years (Table 1 and Fig. 3). Maximum infestation (20.19% DL) was observed in fourth week of September (39th SMW). Then after it was started declining up to 43th standard meteorological week. Minimum infestation of leaf folder (0.98% DL) was noticed during fourth week of October (43th SMW). Present result is in close confirmation with work done by Kushwaha (1988) [20] who reported that rice leaf folder peak infestation was observed during the second week of September, when the rice crop was at the booting to panicle emergence stage. According to Khan *et al.* (1996) [17] and Kraker *et al.* (1999) [18], population dynamics of leaf folder was observed with maximum abundance in the month of September. Sabir *et al.* (2006) [25] reported that the population of rice leaf folder attained their peaks in September. Kakde (2014) [15] from Gujarat reported that incidence of leaf folder reached peak level during 4th week of September (39th SMW) under convectional and SRI method. Netam and Gupta (2015) [21] reported that the infestation of rice leaf folder (15.2%) was observed throughout the cropping period with maximum infestation of 25.3 per cent during third week of September. Jasrotia *et al.* (2019) [12], reported that the per cent damaged leaves by leaf folder attained peak during 3rd week of September (38th SMW). Gajjar (2017) [9] from Gujarat reported that the minimum per cent damaged leaves were observed during fourth week of October (43rd SMW). Ingle and Raghuraman (2019) [10] investigated that the infestation of leaf folder was noticed in the field from 31st SMW to 41st SMW during both years of study. The maximum damaged leaves was recorded in 39th SMW (11.10%) during *Kharif*-2017. Slight deviation in the number of larvae and per cent damaged leaves by leaf folder could be due to variation in the cropping pattern, sowing period of the crop and environmental conditions prevailed in a particular locality during the season.

Correlation coefficient ('r') between rice leaf folder, *C. medinalis* infestation and weather parameters

An attempt was made to determine the relationship between numbers of larvae and per cent damaged leaves with various weather parameters. Correlation coefficients ('r') between number of larvae and per cent damaged leaves and weather parameters were calculated for both the years of study. The values thus obtained are presented in Table 2 and Fig. 1 to 3.

Correlation coefficient values (Table 2) indicated that there was significantly negative relationship between numbers of larvae and temperature. Highly significant negative correlation was found between maximum temperature (-

0.6584) and number of larvae per twenty five hills during *Kharif* 2020. Similarly, there was highly significant negative association between maximum temperature (-0.6806) and number of larvae during *Kharif* 2021. Pooled data analysis showed that there was highly significant negative association was found between maximum temperature (-0.6827) and number of larvae. Minimum temperature had non-significant positive (*Kharif* 2020) and negative correlation with number of larvae during *Kharif* 2021 and in pooled. In other hand per cent damaged leaves and temperature had significant negative correlation. Highly significant negative correlation was found between maximum temperature (-0.6071) and per cent damaged leaves during *Kharif* 2020. In *Kharif* 2021, there was highly significant negative association was found between maximum temperature (-0.6326) and per cent damaged leaves. Minimum temperature had non-significant positive (*Kharif* 2020) and negative correlation with per cent damaged leaves during *Kharif* 2021 and in pooled analysis. Over all in pooled analysis, there was highly significant negative correlation was found between maximum temperature (-0.6494) and per cent damaged leaves. Jhansi *et al.* (2017) [13] reported that leaf folder incidence showed a significant negative correlation average with minimum and average temperatures. Gajjar (2017) [9] also reported that maximum temperature exhibited highly significant negative correlation, minimum temperature exhibited non-significant positive correlation and average temperature exhibited significant negative correlation with number of larvae and per cent damaged leaves. Bhumireddy *et al.* (2018) [6] revealed that there was non-significant negative correlation between leaf folder infestation and minimum temperature. Priya and Rabindra (2021) [22] revealed that there was non-significant negative relationship found with minimum temperature with rice leaf folder incidence. Kumar *et al.* (2022) [19] reported that maximum temperature showed a negative correlation with leaf folder infestation. These reports are in accordance with the present finding wherein maximum, minimum and average temperature influenced negatively with the number of larvae and per cent damaged leaves.

Table 2: Correlation coefficient ('r') of rice leaf folder, *Cnaphalocrocis medinalis* infestation with weather parameters

Correlation coefficient ('r')							
***Kharif* 2020**							
	1	**2**	**3**	**4**	**5**	**6**	**7**
	Temperature (°C)		**Relative Humidity (%)**		**RF (mm/week)**	**RD (no./week)**	**SSH (hrs/day)**
	Max. T.	**Min. T.**	**Max. RH**	**Min. RH**			
Number of larvae	-0.6584**	0.2496	0.6552**	0.5813*	0.1587	0.1617	-0.5424*
% damaged leaves	-0.6071**	0.2191	0.6082**	0.5946*	0.1669	0.1874	-0.5309*
***Kharif* 2021**							
Number of larvae	-0.6806**	-0.3351	0.5544*	0.4592*	0.5977*	0.3943	-0.6494**
% damaged leaves	-0.6326**	-0.3550	0.6130**	0.4968*	0.4997*	0.2173	-0.6314**
Pooled of *Kharif* 2020 & 2021							
	Temperature (°C)		**Relative Humidity (%)**		**RF (mm/week)**	**RD (no./week)**	**SSH (hrs/day)**
	Max. T	**Min. T**	**Max. RH**	**Min. RH**			
Number of larvae	-0.6827**	-0.0643	0.6321**	0.5471*	0.3826	0.3202	-0.6767**
% damaged leaves	-0.6494**	-0.0469	0.6469**	0.5612*	0.3043	0.2219	-0.6575**
*Significant at 5% level				** Significant at 1% level			
Max. T= Maximum Temperature, Min. T= Minimum Temperature, Max. RH= Maximum Relative Humidity, Min. RH= Minimum Relative Humidity, RF= Rain Fall, RD= Rainy Days and SSH= Sunshine Hours							

Maximum and minimum relative humidity influenced positively with the number of larvae and per cent damaged leaves. There was highly significant positive correlation was found between maximum relative humidity and number of larvae (0.6552) and per cent damaged leaves (0.6082). Significant positive correlation had found between minimum relative humidity and number of larvae (0.5813) and per cent damaged leaves (0.5946) during *Kharif* 2020. Similarly, in second year of study there was significant positive association found between number of larvae and maximum (0.5544) and minimum (0.4592) relative humidity. In case of per cent damaged leaves, highly significant positive correlation had found with maximum relative humidity (0.6130). Significant positive association found between per cent damaged leaves and minimum relative humidity (0.4968) during *Kharif* 2021. Over all in pooled analysis, maximum relative humidity (0.6321) had highly significant positive correlation while minimum relative humidity (0.5471) had significant positive relationship with number of larvae. Same as in number of larvae, maximum relative humidity (0.6469) had highly significant positive correlation and minimum relative humidity (0.5612) had significant positive relationship with per cent damaged leaves. These results are in agreement with the findings of Deepa *et al.* (2009) [8] and Sabir *et al.* (2006) [25], who reported that humidity imparts positive impact on population development of rice leaf folder. Chakraborty and Deb (2011) [7] found that maximum relative humidity and average relative humidity had significant positive influence on *C. medinalis* population. This is in close agreement with the report of Gajjar (2017) [9], who reported that per cent damaged leaves and number of larvae showed significant and positive correlation with morning, evening and average relative humidity.

Rainfall had found non-significant positive correlation with the number of larvae (0.1587) and per cent damaged leaves (0.1669) during *Kharif* 2020 and in pooled with number of larvae (0.3826) and per cent damaged leaves (0.3043). In contrast to above, during *Kharif* 2021, rainfall had found significant positive association with number of larvae (0.5977) and per cent damaged leaves (0.4997). This is in accordance with the finding of Khan *et al.* (2004) [16], Chakraborty and Deb (2011) [7], Priya and Rabindra (2021) [22] and Kumar *et al.* (2022) [19], who reported that rainfall imparted non-significant positive effect on population development of rice leaf folder. Gajjar (2017) [9] observed that per cent damaged leaves and number of larvae had significant

and positive correlation with rainfall.

Rainy days had found non-significant positive correlation with the number of larvae (0.1617) and per cent damaged leaves (0.1874), number of larvae (0.3943) and per cent damaged leaves (0.2173) and number of larvae (0.3202) and per cent damaged leaves (0.2219) during *Kharif* 2020, *Kharif* 2021 and in pooled, respectively. This is in agreement with the report of Chakraborty and Deb (2011) [7] and Priya and Rabindra (2021) [22], who reported that number of rainy days imparted non-significant positive effect on population development of rice leaf folder. Sunshine hours influenced significant negative correlation with the number of larvae (-0.5424) and per cent damage leaves (-0.5309) during *Kharif* 2020. Highly significant negative correlation had found between sunshine hours and number of larvae (-0.6494) and (-0.6767) during *Kharif*-2021 and in pooled, respectively. Highly significant negative correlation had found between sunshine hours and per cent damage leaves (-0.6314) and (-0.6575) during *Kharif* 2021 and in pooled, respectively. Chakraborty and Deb (2011) [7] observed that sunshine hours had negative influence on rice leaf folder incidence and Gajjar (2017) [9] reported that significant negative correlation was found between sunshine hours and rice leaf folder.

Conclusion

The leaf folder population on rice crop started to build up three week after establishment of transplanted paddy seedlings (31st SMW) and continued up to 42nd and 43rd SMW. The maximum populations were found in 38th and 39th SMW and remained continuously up to the harvest of the crop. The correlation between the leaf folder population and abiotic factors was tested. Significant positive correlation with maximum and minimum relative humidity while significant negative correlation with maximum temperature and sunshine hours. Others parameters showed a non-significant positive and negative relationship with the population of rice leaf folder.

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References

1. Anonymous. District-wise area, production and yield of important food and non-food crops in Gujarat state. Directorate of Agriculture (Gujarat); c2021. p. 1-106.
2. Anonymous. Eco-regional based rice farming for enhancing productivity, profitability and sustainability. NRRI Research Bulletin. 2020;22:1-32.
3. Appala RK, Krishnayya PV, Sai Ram Kumar DV, Krishnaveni B, Manoj Kumar V. Correlation studies and multiple linear regression analysis of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) incidence with biochemical characters of leaves of the rice varieties. International Journal of Chemical Studies. 2018;6(5):3133-3138.
4. Bhanu KV, Reddy PS. Field evaluation of certain newer insecticides against rice insect-pests. Journal of Applied Zoological Research. 2008;19(1):11-14.
5. Bhatti MN. Rice leaf folder (*Cnaphalocrosis medinalis*): A review. Pakistan Journal of Entomology. 1995;17:126-131.
6. Bhumireddy S, Simon S, Nagar S. Seasonal incidence of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) in Allahabad region. Journal of Pharmacognosy and Phytochemistry. 2018;7(4):2528-2530.
7. Chakraborty K, Deb DC. Incidence of adult leaf folder, *Cnaphalocrocis medinalis* (Lepidoptera: Pyralidae) on paddy crop in the agro climatic conditions of the northern parts of West Bengal, India. World Journal of Agricultural Sciences. 2011;7(6):738-742.
8. Deepa M, Agarwal NR, Viswakarma KK, Lal KM. Monitoring and weather parameters on *Bactrocera* complex through methyl eugenol traps. Annals of Plant Protection Sciences. 2009;17(2):332-336.
9. Gajjar SN. Management of rice leaf folder *Cnaphalocrocis medinalis* Guenee (pyralidae: lepidoptera) under south Gujarat condition. PhD thesis, Navsari Agricultural University, Navsari; c2017. p. 1-168.
10. Ingle DS, Raghuraman M. Effect of abiotic factors on incidence of leaf folder, *Cnaphalocrocis medinalis* (Guenne) in rice ecosystem of Varanasi region. Pharma Innovation Journal. 2019;8(3):31-34.
11. Jakarpong S, Wiboon C. Influence of humidity, rainfall, and fipronil toxicity on rice leaf folder (*Cnaphalocrocis medinalis*). Science Asia. 2017;43:82-87.
12. Jasrotia P, Khippal A, Yadav J, Prem Lal K, Kumar S, Singh G. Effect of weather variables on the incidence of yellow stem borer (Scirpophaga incertulas W.) and leaf folder (*Cnaphalocrocis medinalis* G.) in rice. Journal of Cereal Research. 2019;11(3):247-251.
13. Jhansi LV, Sunil V, Sampath Kumar M, Bentur JS, Katti GR, Vennila S. Population dynamics of rice insect pests in Yadagirigutta Mandal (Nalgonda District)-under climate change perspective. Journal of Rice Research. 2017;10(2):70-74.
14. Kafle K, Subedi R, Sapkota B, Shahi S. Effects of various weather factors in seasonal variation of insect pest in rice in Sundar Bazar, Lamjung. International Journal of Research in Agricultural Sciences. 2018;5(4):2348-3997.
15. Kakde AM. Succession of rice pest complex and testing of different management modules against rice pest complex under south Gujarat condition. PhD thesis, Navsari Agricultural University, Navsari; c2014. p. 70-224.
16. Khan ZH, Ramamurthy VV. Influence of weather factors on the activity of rice leaf folder, *Cnaphalocrocis medinalis*. Annals of Plant Protection Sciences. 2004;12(2):267-270.
17. Khan ZR, Abenes MLP, Fernandez NJ. Suitability of graminaceous weed species at host plant for rice leaf folders, *Cnaphalocrocis medinalis* and *Marasmia patnalis*. Crop Protection; c1996. p. 15:27.
18. Kraker JA, Huis KL, Heong JCL, Rabbing R. Population dynamics of rice leaf folder and their natural enemies in irrigated rice in Philippines. Bull. Entomol. Res. 1999;89:411-421.
19. Kumar A, Gagan D, Nath R, Singh A. Effects of date of transplanting on the incidence of rice leaf folder *Cnaphalocrocis medinalis* (Guenee) and its population dynamics. Indian Journal of Entomology. 2022, 1-3. (Ref. No. e21121).
20. Kushwaha KS. Leaf folder epidemic in Haryana, India. Int. Rice Research Newsletter. 1988;13(3):16-17.

21. Netam CS, Gupta AK. Seasonal incidence of rice leaf folder, *Cnaphalocrosis medinalis* (Guenee) in agro climatic condition of at baster plateau zone. Annals of plant and soil research. 2015;17(1):24-28.
22. Priya P, Rabindra P. Population dynamics of rice leaf folder in relation to weather factors at Ranchi. International Journal of Science, Engineering and Management. 2021;6(6):2456-1304.
23. Rajendran R, Rajendran S, Sandra PC. Varietals resistance of rice of leaf folder. International Rice Research News; c1986. p. 11:17.
24. Reddy PP. Recent advances in crop protection.1. Springer New Delhi; c2013. p. 268. https://link.springer.com/book/10.1007/978-81-322-0723-8.
25. Sabir AM, Ahmad S, Hassan M, Qadir A. Pest weather interaction of major insect pests in rice ecosystem. SAARC Journal of Agriculture. 2006;4:203-212.
26. Shanmungam TR, Sendhil R, Thirumalvalavan VV. Quantification and prioritization of constraints causing yield loss in rice (*Oryza sativa*) in India. Agricultura Tropica et Subtropica. 2006;39:194-201.