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Impact of Weather Parameters on Seasonal Incidence of Oriental Armyworm, *Mythimna separata* (Lepidoptera; Noctuidae) Infesting Maize Ecosystem in North Kashmir

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Authors' contributions

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

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ABSTRACT

The investigation on the seasonal incidence of oriental armyworm, *Mythimna separata* was conducted at the Faculty of Agriculture, Wadura SKUAST-K during kharif 2021. Shalimar composite-6 maize variety was cultivated under the standard practices for Kashmir valley, recommended by SKUAST-K. The pest activity during the crop growth period was monitored by using light traps and visual observations. Findings revealed that adult *M. separata* on maize emerged in the 18th standard meteorological week (SMW) with its peak in the 24th week and

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remained active until the 37th week. Similarly, armyworm caterpillars appeared in the 19th to 37th SMW and reached their peak in the 29th week in the maize ecosystem during 2021. Moreover, the percentage of infestation during the Kharif season was found to be minimum of 10 per cent in the 19th SMW, reaching its peak of 63 per cent in the 29th SMW. The infestation gradually decreased and persisted for eight weeks, with 10 per cent infestation in the 37th SMW. The relationship between adult population and weather parameters showed a positive correlation with maximum temperature (r = 0.14) and a negative correlation with minimum temperature (r = -0.22), morning relative humidity (r = -0.52*) and evening relative humidity (r = -0.47*). However, *M. separata* adult populations showed a significant negative association with rainfall (r = -0.51*). Correlations drawn between important weather parameters and larvae of *M. separata* showed significant positive correlation with maximum temperature (r = 0.60**) and minimum temperature (r =0.56**), while morning RH (r = -0.36) and evening RH (r = -0.29) showed negative association and rainfall (r =-0.16) also exhibited negative association with the larval infestation of *M. separata* during Kharif 2021. The study on percentage infestation also demonstrated a significant positive correlation with maximum temperature (r = 0.47*) and minimum temperature (r = 0.53*), while morning relative humidity (r = -0.22) and evening relative humidity (r = -0.29) showed negative associations. Rainfall (r = -0.20) displayed a negative correlation with the per cent infestation of *M. separata.*

Keywords: Maize; Mythimna separata; seasonal incidence; weather parameters.

1. INTRODUCTION

Maize (*Zea mays* L.) holds the global top ranking among food crops, followed closely by wheat and rice and is renowned for its versatility across various agro-ecological locations worldwide [1]. Termed a 'miracle crop' due to its extensive economic applications, maize serves as a vital industrial raw material for the production of glucose, starch, dextrin, corn flakes and corn oil meets nutritional needs [2]. Additionally, maize contributes to the production of pharmaceuticals and alcoholic beverages and its cobs find utility in various applications such as cleaning, brushing, polishing and serving as carriers for pesticides, rubber compounds and tires [3]. In India, maize allocation includes 28 per cent for food, 11 per cent for livestock feed, 48 per cent for poultry feed, 12 per cent in the wet milling industry (starch and oil production) and 1 per cent for seed. Referred to as the 'Queen of cereals' maize boasts the highest yield potential among cereal crops globally, playing a crucial role in addressing food security concerns, especially in countries like India with burgeoning populations [1]. In India, maize cultivation serves various purposes, encompassing human consumption, cattle and poultry feed, food processing and the extraction of starch, dextrose, corn syrup, and corn oil [4]. Maize with its composition of approximately 72 per cent starches, 10 per cent protein and 4 per cent fat, supplying an energy density of 365 Kcal/100 g, faces challenges from a myriad of pests, including insects, nematodes, mites, birds and rodents. As many as 141 insect pests cause varying degrees of damage to maize from sowing to harvest, with Kashmir valley experiencing cultivation challenges under rainfed conditions. Biotic stresses, particularly insect pests, contribute to a 15.6 per cent loss in yield in Kashmir. Maize is attacked by 140 different insect species, with only 12 species identified as serious pests causing damage throughout the cultivation and storage stages [5,6]. Among these pests, *M. separata* (Walker) emerges as a significant threat to cereal crops and pasture grasses in East Asia, Southeast Asia, Eastern Australia and certain Pacific Islands [7,8]. This pest, causing intermittent outbreaks at high densities, leads to complete yield loss [9,10]. Considering the significance of the maize crop and the economic losses incurred due to *M. separata* during the kharif season, this study aims to investigate the population dynamics of *M. separata* in relation with weather parameters. The goal was to understand the seasonal distribution, activity patterns, polyphagous nature and host habitat-finding behavior in correlation with fluctuations in abiotic weather parameters. The study also seeked to propose precautionary measures to prevent pest outbreaks during the cropping season.

2. MATERIALS AND METHODS

The investigation was carried out at the Faculty of Agriculture, SKUAST-K, Wadura in 2021 to evaluate the per cent infestation, adult and larval population of *M. separata* and their correlation with weather parameters *viz.,* (temperature, humidity, and rainfall) in the maize ecosystem.

Maize variety Shalimar composite-6 was planted, according to the standard package of techniques recommended by SKUAST-K for the Kashmir valley. Ten plants were randomly selected from each selected plot for the observations of larval incidence and per cent infestation was taken weekly through the entire cropping season.

Per cent infestation was calculated by using the formula given below:

$$Per\ cent\ infestation = \frac{No.of\ infested\ plants}{Total\ no.of plants} \times 100$$

Light traps were set up to monitoring the nocturnal moth from dusk to dawn to study the adult population of *M. separata*.

To determine the effects of various weather parameters on per cent infestation, adult and the larval populations of *M. separata* were correlated with weather parameters *viz.,* maximum temperature, minimum temperature, relative humidity morning, relative humidity evening and total rainfall. The periodicities of observations at weekly intervals were planned as per the standard weeks during the entire crop season. The data generated was subjected to standard statistical procedures for agricultural research [11].

3. RESULTS AND DISCUSSION

3.1 Adult Incidence of Oriental Armyworm, *Mythimna separata* in Maize Eco-system

The perusal of data on adult population of *M. separata* indicates the appearance from the 18th SMW with a minimum population of 1.50 adults per plant and reached its peak during the 24th SMW with a maximum population of 13.50 adults per trap after reaching its peak, the overall incidence gradually declined and lasted up to 13th SMW with the adult population of 2.00 adults per trap (Table 1 and Fig. 1). Our results are in line with the findings showing maximum population catches of 72 moths of rice stem borer during 47th SW [12].

The perusal of data presented in Table 2 revealed that correlations drawn between important weather parameters with the adult of *M. separata* resulted in positive correlation with maximum temperature (r = 0.14) and a negative correlation with minimum temperature (r = -0.22). Morning RH (r = -0.52*) and evening RH (r = -0.47*), showed a significant negative association with the *M. separata* adults. Our results are in line with the observations presenting first adult male moth of *Leucinodes orbonalis* trapped during 24th SMW from different locations of district Kupwara and the peak population of adult moths was observed during the 34th SMW. Additionally, abiotic factors and adult moth catch of *L. orbonalis* were correlated at all the locations, had a positive and significant correlation with minimum temperature, while maximum temperature, rainfall and relative humidity (evening) had positive and non-significant correlation, though relative humidity (morning) had negative and non-significant correlation [13]. Moth catch was significantly and positively correlated with both maximum and minimum temperature and negatively correlated with relative humidity, whereas rainfall did not influence the trap catch significantly [14].

3.2 Larval Incidence and Correlation of Oriental Armyworm, *Mythimna separata* with Weather Parameters in Maize Eco-system

The data presented in Table 1 and Fig. 1 on the larval population of *M. separata* was noticed from 18th SMW with 0.30 larvae/plant and the population reached its peak during 29th SMW with the maximum population of 4.10 larvae/plant, respectively. After the peak, the overall incidence gradually declined and lasted up to six weeks with a larval population of 0.30 larvae/plant at 37th SMW on maize. Our study agrees with the workers who reported the maximum peak activity of fall armyworm in the month of March and observed the infestation and distribution of fall armyworm increasing from January to March month [15,16]. The tobacco caterpillar, *Spodoptura litura* occurred from first week of August (31st SW) where the mean larval population was 0.21 plant-1, gradually increased and reached to its maximum (7.01 plant-1) by last week of September (39th SW). Thereafter, the population declined but continuously observed till harvest (0.23 plant-1) [17].

The perusal of data presented in Table 2 revealed that the correlations drawn between important weather parameters and the larval *M. separata* showed a significant positive correlation with maximum temperature (r = 0.60**) and minimum temperature (r =0.56**). Morning RH (r = -0.36) and evening RH (r = -0.29) showed a negative association and rainfall (r =-0.16) also exhibited a negative association with the larval

Table 1. Seasonal incidence of oriental armyworm, *Mythimna separata* infesting maize in North Kashmir

Standard Meteorological Week (SMW)	Kharif season 2021			Weather parameters				
	Adult/trap	Larvae/Plant	Percent Infestation	Maximum Temp. (ºC)	Minimum Temp.(ºC)	Morning RH	Evening RH	Rainfall
18th	2.00	0.00	0.00	24.5	9.28	71.85	54.44	0.4
19th	3.00	0.33	10.00	22.57	10.14	79.57	66.42	3.6
20th	3.00	0.66	14.00	24.21	8.92	86.85	46.57	1.65
21th	7.00	0.66	17.00	23.92	8.07	78.28	48.85	1.97
22th	9.00	1.33	20.00	27.85	11.64	77.28	56.57	0.45
23th	13.00	1.51	22.00	32.42	15.28	69.14	39.71	0
24th	13.50	1.73	24.00	27.35	13.64	74.14	50.85	2.07
25th	9.50	2.50	37.00	28.84	12.14	67	37.71	0.17
26th	10.50	3.20	41.00	31.21	13.42	60.14	38.57	0.37
27th	3.00	3.50	53.00	30.44	15.14	69.42	38.14	1.72
28th	2.00	3.70	57.00	30.04	17.98	76.28	44.14	2.1
29th	1.50	4.10	63.00	28.7	18.01	82.14	55	1.7
30th	0.00	3.50	35.00	31.22	19.77	77.85	59.71	7.54
31th	0.00	1.70	17.00	29.8	17.48	82.85	60	9.4
32th	0.00	1.50	15.00	29.88	15.3	71.71	54.71	2.25
33th	2.00	1.30	12.00	29.28	13.61	79.57	46.71	13.25
34th	3.00	0.50	12.00	32.52	15.51	74.57	40.42	2.1
35th	5.00	0.20	10.00	29.21	13.5	75.14	45.42	0.51
36th	4.50	0.30	10.00	31.12	14.94	74.14	44.57	0
37th	2.00	0.30	10.00	26.64	13.55	83.71	58.71	14.08

Table 2. Correlation between weather parameters and weekly observations on adult, larval population and per cent infestation of oriental armyworm, *Mythimna separata*

Kharif season (2021)	Weather parameters				
	Max.Temp. (ºC)	Max.Temp. (ºC)	Morning RH	Evening RH	Rainfall
Adult/ plant	0.14	-0.22	-0.52*	-0.47*	-0.51*
Larvae/Plant	0.60**	0.56**	-0.36	-0.29	-0.16
Percent Infestation	0.47*	0.53*	-0.22	-0.29	-0.20

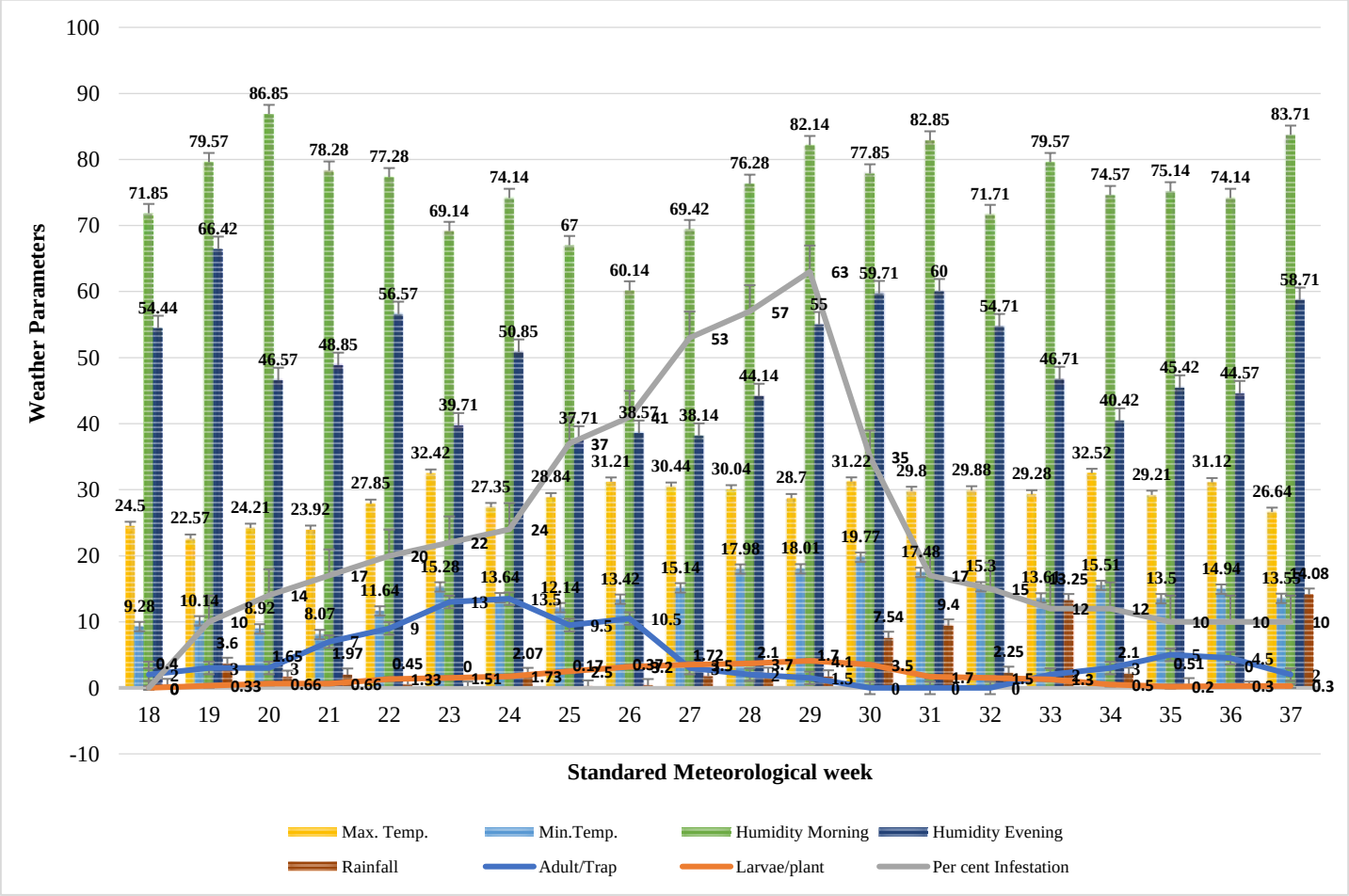

Fig. 1. Seasonal incidence of oriental armyworm, *Mythimna separata* infesting maize in North Kashmir

infestation of *M. separata*. Our study is in hormony with the workers who observed that the larval population of fall armyworm was positively correlated with maximum temperature (r = 0.72) and negatively correlated with both relative humidity (- 0.5473) and rainfall (-0.5874) in Perambalur, district of Tamil nadu [18]. Other findings also show that the larval population density of fall armyworm was positively and significantly correlated with temperature [19,20].

3.3 Percent Infestation and Correlation of Oriental Armyworm *Mythimna separata* with Weather Parameters in Maize Eco-system

The data present in Table 1 and Fig. 1 reveals that the per cent infestation commenced from the 19th SMW at 10 per cent and reached its peak on the 29th SMW with 63 per cent infestation and showed a declining trend from the 30th SMW and lasted upto the 8th SMW with 10 per cent infestation on the 37th SMW. The incidence of *M. separata* in our studies was similar to the findings indicating the infestation of maize stem borer (*Chilo partellus*) commenced from the 24th standard week till the 40th standard week and the peak leaf infestation was observed in the 32nd SMW at 48.05 per cent from where it started declining and reached to a minimum in 40th standard week at 13.05 per cent [21]. The per cent infestation of stem borers varied during different months and the highest infestation of 19.22 per cent was observed in the month of August followed by July (15.80 per cent) and September (15.10 per cent) [22]. Maximum population and per cent infestation of *S. litura* (Fabricius) on groundnut was observed during 13th SMW with 3.80 larvae per meter row and 60.1 per cent infestation [23]. Maximum population of stem borer was found during 37th standard week of September [24].

The result of correlation study with per cent infestation revealed that per cent infestation of *M. separata* resulted in significant positive correlation with maximum temperature (r = 0.47*) and minimum temperature (r =0.53*). Morning RH (r = -0.22) and evening RH (r = -0.29) showed a negative association and rainfall (r =-0.20) also exhibited negative association with the per cent infestation of *M. separata* (Table 2). Our study is almost in close conformity with the observations showing that the maximum temperature was positively correlated with fall armyworm infestation and in addition, the relative humidity was negatively correlated with *S. frugiperda* infestation [25].

4. CONCLUSION

The research indicates that the adult *M. separata* presence on maize commenced in the 18th standard meteorological week, peaked in the 24th week and persisted until the 37th week. In contrast*, M. separata* caterpillars emerged in the 19th SMW, peaked in the 29th week and remained active until the 37th week in the maize ecosystem during 2021. The minimum infestation of 10 per cent occurred on the 19th SMW, with the peak infestation of 63 per cent observed on the 29th SMW during the kharif season. Infestation decreased over eight weeks, reaching 10 per cent on the 37th SMW. Correlation analysis between weather parameters and weekly catches of adult *M. separata* showed a positive correlation with maximum temperature (r = 0.14) and a negative correlation with minimum temperature (r = -0.22). Morning RH (r = -0.52*), evening RH (r = -0.47*) and rainfall (r = -0.51*) showed a significant negative association with the *M. separata* adults during kharif 2021. The correlations drawn between important weather parameters with the larval *M. separata* revealed a significant positive correlation with maximum temperature (r = 0.60**) as well as minimum temperature (r = 0.56**). Morning RH (r = -0.36), evening RH (r = -0.29) and rainfall (r = -0.16) exhibited negative associations with larval infestation. Similarly, the per cent infestation of *M. separata* demonstrated a significant positive correlation with maximum temperature (r = 0.47*) and minimum temperature (r = 0.53*). Morning RH (r = -0.22), evening RH (r = -0.29) and rainfall (r = -0.20) showed negative association with the per cent infestation.

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COMPETING INTRESTS

We, all the authors declare that no competing interests exist.

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