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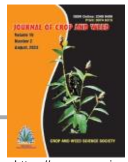

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Population fluctuation of leaf eating insect pests through climatic factors on cabbage

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ABSTRACT

Population fluctuations of cabbage leaf eating insect pests were investigated at College of Agriculture, Kota (Rajasthan) during winter 2020-21. The larval populations of the diamondback moth and tobacco caterpillar first emerged in the last week of November (47th SMW). Green semilooper, on the other hand, was first noticed in the second week of December (50th SMW), They slowly enhanced and reached their peaks respectively in the first week of January (1st SMW), (5.6 larvae plant^{-1}), the last week of December (52nd SMW), (4.1 larvae plant^{-1}), and the third week of January (3rd SMW), (2.6 larvae plant^{-1}). There was a strong negative correlation of all pests with both of highest and lowest temperatures. The DBM and tobacco caterpillar showed non-significant negative correlations with morning and evening relative humidity. The same was non-significant and positive in case of green semilooper.

***Keywords*:** Abiotic elements, cabbage, connection, insect infestations and seasonal variation

In the crucifers in India and Rajasthan, cabbage (*Brassica oleracea var. capitata* L.) is a significant vegetable crop. It is used to make pickles, salads, curries, and boiling vegetables. It also has a good amount of iron, calcium, and potassium, as well as vitamins C, B1, B2, and B3. Our nation produces 9.213 MT of cabbage annually from 398 thousand ha of area with an average productivity of 23.19 t ha^{-1}, whereas Rajasthan contributes 12.74 thousand Metric tons of cabbage production from an area of 1.19 thousand ha with a productivity of 10.64 t ha^{-1}(NHB, 2019-20).

One of the key problems for the gainful growing of cabbage is insect infestations. Under ideal circumstances, these pests can harm nurseries to an amount of 80 to 100% and fields to an extent of 10 to 25%. Due to differences in the cropping time and climatic conditions, different insect-pests have different seasonal incidences in different regions. Fifty one (51) insect pests that harm cruciferous crops globally were listed by Maison (1965). According to Lal (1975) thirty seven insect pests have been identified as feeding on cabbage in India. Whereas, the diamondback moth, *Plutella xylostella*, is the most significant obstacle to the productive production of cole crops wherever they are planted (Talekar *et al.*, 1993). According to Sharma *et al.* (2017), *Plutella xylostella* infestation peaked (45.2 larvae plants^{-10}) in the first week of January and began in the third week of November. They proved remarkable negative correlation of DBM larval population with temperatures.

The current climatic conditions, which differ from part to part, have a significant impact on the intensity of pest infestation. Environmental conditions are crucial in determining the seasonal fluctuating of infested insect pests and the harm they cause. Thus, research into the impact of diverse abiotic factors affecting the population fluctuation of significant insect pests on cabbage crop is important. Studying insect population dynamics is essential to forecasting and analyzing how various insect species will respond to environmental factors (such as weather patterns) that are "fluctuating daily, seasonally, or as a result of long-term effects of global climate change." The objective of the current study was to get a fundamental understanding of the seasonal fluctuation pattern of important insect pests in relation to various meteorological conditions in order to appropriately plan effective and timely pest interventions.

MATERIALS AND METHODS

During *rabi* 2020–21, a field experiment was carried out at the experimental farm of the COA, Ummedganj–Kota, Rajasthan. The experimental site is 12 kilometers from the Kota district headquarters in the eastern section of the district, at a height of 258 meters above mean sea level and at 25°11'0" North and 75°50'0" East. The area is located in Rajasthan's Humid South-East Plain Zone.

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This region experiences typical sub-tropical weather, with mild winters and long, hot, dry summers that begin in late March and run through the end of June. The coldest temperature in December was 6.36 °C, with the average temperature in May remaining over 40 °C and regularly exceeding 48 °C in June. The average annual rainfall was 716.6 mm. Table 1 shows the temperature and percentage of relative humidity for the experimental period of *rabi* 2020–21.

For growing cabbage seedlings, a nursery bed of 3m x 1m x 0.15 m was prepared. Neelima-F1 variety was sown in raised beds. The seeds were covered with a thin layer of fine soil and well-rotten FYM. Regular weeding, hoeing, watering, plant protection, etc. were carried out.

After the *kharif* crop was harvested, weeds and crop remnants were cleared from the field, and a deep ploughing, two cross ploughings, and levelling with heavy plank were applied to restore good condition. On November 6, (2020), 30 days old seedlings were transplanted with a 45 cm plant-to-plant and 60 cm row-to-row spacing. The seedlings were planted between 2.5 and 3 cm deep. Each replicated plot's dimensions were kept constant at 4.5 x 3.6 m^2.

After transplanting from an untreated plot, observations will be made, and they will continue at weekly intervals until the crops have been cleared of the boarder rows but the pest infestation is still there. Larval population of diamondback moth, cabbage semilooper and tobacco caterpillar was counted at 7 days interval following standard meteorological week throughout the crop period at morning hours.The larval population for each pest was counted visually from randomly selected 5 plants per replicated plot using the direct visual counting method to estimate the larval population of the pest that eats leaves. Data from the experimental study were statistically analyzed using the Randomized Block Design (RBD).

RESULTS AND DISCUSSION

1. Diamond back moth (*P. xylostella* L.)

The larval population of diamondback moth first appeared in the last week of November (48th SMW) which gradually increased and reached to peak in the first week of January (1^{st} SMW), (6.3 larvae $plant^{-1}$) at 24.6°C maximum and 9°C minimum temperatures, 76.00% morning and 66.00% evening relative humidity thereafter, population started declined (Table 1). The correlation studies revealed that the diamondback moth larval population had significant negative correlation with maximum and minimum temperatures (r = -0.678 and r = -0.626), whereas, showed non-significant negative correlation with morning relative humidity (r = -0.243) and evening relative humidity (r = -0.270). The correlation studies showed that the incidence of diamondback moth was affected only by temperature. Similar findings were supported by another worker. According to Sharma *et al.* (2017), the diamondback moth (*P. xylostella*) infestation peaked (45.2 larvae $plants^{-10}$) in the first week of January and began in the third week of November. The maximum and minimum temperatures significantly correlated negatively with the diamondback moth larval population, although the relative humidity and sunshine hours did not. According to Aiswarya *et al.* (2018), there were an average of 4.6 larvae $plant^{-1}$ when the diamondback moth (*P. xylostella*) first appeared in the final week of November (47^{th} MW). The population gradually rise and peaked in the third week of December with a mean of 5.2 larvae $plant^{-1}$ (51^{th} SMW). Diamondback moth infestation was researched by Bana *et al.* (2012), who found that it peaked in the first week of January after beginning in the third week of November. The relative humidity and sunshine hours did not significantly correlate with the diamondback moth larval population, but the maximum and minimum temperatures affect it. According to Vanlaldiki *et al.* (2013), *P. xylostella* larvae started at the end of January and gradually increased until they peaked by the end of March. Other studies that support DBM include those from Palande *et al.* (2004), Shukla and Kumar (2004), Alam *et al.* (2016), Anjali and Pandya (2019), and Sahu and Pachori (2020).

2. Green semilooper (*T. nii* Hub.)

In *rabi*, 2020-21, the larval population of green semilooper was first appeared in the second week of December (50^{th} SMW) which gradually increased and reached to peak in the third week of January (3^{rd} SMW), (2.6 larvae $plant^{-1}$) at 23.89°C maximum and 6.36°C minimum temperatures, 99.57% morning and 68.14% evening relative humidity thereafter, population started declined (Table 2). The correlation studies revealed that the green semilooper larval population had significant negative correlation with maximum and minimum temperatures (r = -0.836 and r = -0.760), whereas, non-significant positive correlation with morning and evening relative humidity (r = 0.306 and r = 0.228). The correlation studies showed that the incidence of green semilooper was affected only by temperature, which indicated that the rise in temperature declined the population of green semilooper. The current findings are roughly in line with those of earlier researchers like Aiswarya *et al.* (2018), who found that the cabbage semilooper was common and that there were an average of 1.06 larvae per plant during the last week of November (47^{th} MW). Then, throughout the years of 2016 to 2017, the larval population grew and peaked at 1.2 larvae $plant^{-1}$ in the 49^{th} MW. The mean population

Table 1: Seasonal incidence of diamondback moth and their correlation with their weather parameters during *rabi*-2020-21.

SMW	Duration of SMW	Temperature (°C)		Relative humidity (%)		Mean larval population of DBM (larvae/plant) *
		Maximum	Minimum	Morning	Evening	
45th	05 Nov. 2020 – 11 Nov. 2020	31.94	15.32	89.58	67.27	**0**
46th	12 Nov. 20 – 18 Nov. 20	31.37	14.88	86.45	66.77	**0**
47th	19 Nov. 20 – 25 Nov. 20	30.83	14.00	89.73	70.00	**0**
48th	26 Nov. 20 – 02 Dec. 20	30.43	13.70	89.10	70.27	**0.3**
49th	03 Dec. 20 – 09 Dec. 20	29.27	12.17	89.27	76.18	**0.8**
50th	10 Dec. 20 – 16 Dec. 20	26.69	10.85	88.27	70.44	**1.5**
51th	17 Dec. 20 – 23 Dec. 20	25.60	8.71	87.43	59.14	**2.4**
52th	24 Dec. 20 – 31 Dec. 20	25.10	8.63	77.38	60.00	**3.8**
1st	01 Jan. 2021 – 07 Jan. 2021	24.60	9.00	76.00	66.00	**5.6**
2nd	08 Jan. 21 – 14 Jan. 21	23.39	10.14	99.86	80.14	**3.5**
3rd	15 Jan. 21 – 21 Jan. 21	23.89	6.36	99.71	78.00	**2.9**
4th	22 Jan. 21 – 28 Jan. 21	24.24	6.64	99.57	68.14	**2.3**
5th	29 Jan. 21 – 04 Feb. 21	22.6	6.5	87.7	65.3	**1.7**
6th	05 Feb. 21 – 11 Feb. 21	24.7	9.0	86.0	69.6	**1.3**
7th	12 Feb. 21 – 18 Feb. 21	26.8	10.3	85.0	63.0	**1.1**
8th	19 Feb. 21 – 25 Feb. 21	29.4	12.0	79.4	70.7	**0.8**
	Correlation	**-0.755****	**-0.673****	**-0.130 NS**	**-0.062 NS**	

*Average of 5 plants; *Significant at 5%, **Significant at 1%, NS- non significant.

Table 2: Seasonal incidence of cabbage green semilooper and their correlation with their weather parameters during *rabi*-2020-21.

SMW	Duration of SMW	Temperature (°C)		Relative humidity (%)		Mean larval population of green semilooper (larvae plant^{-1}) *
		Maximum	Minimum	Morning	Evening	
45th	05 Nov. 2020 – 11 Nov. 2020	31.94	15.32	89.58	67.27	**0**
46th	12 Nov. 20 – 18 Nov. 20	31.37	14.88	86.45	66.77	**0**
47th	19 Nov. 20 – 25 Nov. 20	30.83	14.00	89.73	70.00	**0**
48th	26 Nov. 20 – 02 Dec. 20	30.43	13.70	89.10	70.27	**0**
49th	03 Dec. 20 – 09 Dec. 20	29.27	12.17	89.27	76.18	**0**
50th	10 Dec. 20 – 16 Dec. 20	26.69	10.85	88.27	70.44	**0.6**
51th	17 Dec. 20 – 23 Dec. 20	25.60	8.71	87.43	59.14	**0.8**
52th	24 Dec. 20 – 31 Dec. 20	25.10	8.63	77.38	60.00	**1.6**
1st	01 Jan. 2021 – 07 Jan. 2021	24.60	9.00	76.00	66.00	**2.1**
2nd	08 Jan. 21 – 14 Jan. 21	23.39	10.14	99.86	80.14	**2.4**
3rd	15 Jan. 21 – 21 Jan. 21	23.89	6.36	99.71	78.00	**2.6**
4th	22 Jan. 21 – 28 Jan. 21	24.24	6.64	99.57	68.14	**1.6**
5th	29 Jan. 21 – 04 Feb. 21	22.6	6.5	87.7	65.3	**1.2**
6th	05 Feb. 21 – 11 Feb. 21	24.7	9.0	86.0	69.6	**0.8**
7th	12 Feb. 21 – 18 Feb. 21	26.8	10.3	85.0	63.0	**0.2**
8th	19 Feb. 21 – 25 Feb. 21	29.4	12.0	79.4	70.7	**0**
	Correlation	**-0.836****	**-0.760****	**0.306 NS**	**0.228 NS**	

***Average of 5 plants; *Significant at 5%, **Significant at 1%, NS- non significant.**

Table 3: Seasonal incidence of tobacco caterpillar and their correlation with their weather parameters during *rabi*-2020-21.

SMW	Duration of SMW	Temperature (°C)		Relative humidity (%)		Mean larval population of Tobacco caterpillar (larvae plant^{-1}) *
		Maximum	Minimum	Morning	Evening	
45th	05 Nov. 2020 – 11 Nov. 2020	31.94	15.32	89.58	67.27	**0**
46th	12 Nov. 20 – 18 Nov. 20	31.37	14.88	86.45	66.77	**0**
47th	19 Nov. 20 – 25 Nov. 20	30.83	14.00	89.73	70.00	**0.2**
48th	26 Nov. 20 – 02 Dec. 20	30.43	13.70	89.10	70.27	**0.4**
49th	03 Dec. 20 – 09 Dec. 20	29.27	12.17	89.27	76.18	**1.2**
50th	10 Dec. 20 – 16 Dec. 20	26.69	10.85	88.27	70.44	**1.8**
51th	17 Dec. 20 – 23 Dec. 20	25.60	8.71	87.43	59.14	**2.8**
52th	24 Dec. 20 – 31 Dec. 20	25.10	8.63	77.38	60.00	**4.1**
1st	01 Jan. 2021 – 07 Jan. 2021	24.60	9.00	76.00	66.00	**3.4**
2nd	08 Jan. 21 – 14 Jan. 21	23.39	10.14	99.86	80.14	**3.2**
3rd	15 Jan. 21 – 21 Jan. 21	23.89	6.36	99.71	78.00	**2.4**
4th	22 Jan. 21 – 28 Jan. 21	24.24	6.64	99.57	68.14	**1.6**
5th	29 Jan. 21 – 04 Feb. 21	22.6	6.5	87.7	65.3	**1.2**
6th	05 Feb. 21 – 11 Feb. 21	24.7	9.0	86.0	69.6	**0.8**
7th	12 Feb. 21 – 18 Feb. 21	26.8	10.3	85.0	63.0	**0.2**
8th	19 Feb. 21 – 25 Feb. 21	29.4	12.0	79.4	70.7	**0**
	Correlation	**-0.695****	**-0.613****	**-0.030 NS**	**-0.064 NS**	

*Average of 5 plants; *Significant at 5%, **Significant at 1%, NS- non significant.

then marginally declined. The average weather conditions during the peak period of incidence were as follows: maximum- minimum temperature, morning-evening relative humidity, hours of bright sunshine, and rainfall. The average values were 30°C, 11.9°C, 74%, 36%, 9.1 hours, and 0.0 mm, respectively. According to Nale *et al.* (2016), there was a strong negative association between the semilooper population and morning relative humidity (r = -0.217) and bright sunshine (r = -0.159). According to the coefficient of determination (R2), the meteorological variables were responsible for 94.28 per cent of the overall variation in the semilooper population on cabbage. Ojha *et al.*, (2004) and Gaikwad performed comparable research as well (2018).

3. Tobacco caterpillar (*S. litura* Fab.)

The population of tobacco caterpillars first appeared in the second to last week of November (47th SMW), gradually increased, and peaked in the last week of December (52nd SMW) with 4.1 larvae per plant at maximum and minimum temperatures of 25.1°C and 8.63°C, respectively, and relative humidity levels of 77.38% in the morning and 60.00% in the evening. Thereafter, the population of tobacco caterpillars began to decline (Table-3). The correlation analyses showed that the population of tobacco caterpillars had a non-significant negative connection with morning and evening relative humidity (r = -0.030 and r = -0.064), but a significant negative correlation with maximum and minimum temperatures (r = -0.695 and r = -0.613). The correlation analyses revealed that only temperature had an impact on the prevalence of tobacco caterpillars, indicating that as temperatures rose, the caterpillar population decreased. The findings supported by Badjena and Mandal (2005) showed that *S. litura* incidence was noted from the fourth week of November to the third week of February. Incidence peaked (21.3 larvae plants^{-10}) in the second week of January. According to Narsimhamurthy *et al.* (1998), the population of larvae showed both significant and non-significant negative Relationships with maximum and minimum temperatures for caterpillar on cauliflower, respectively. The correlation between incidence and relative humidity in the morning was positively non-significant. According to Khan and Talukder (2017), the *S. litura* larval population fluctuated between 0.56 and 1.57 larvae plant^{-1} during the seventh standard week. The largest peak occurred in the sixth week (1.57 larvae plant^{-1}) at a temperature of 29.5 °C. Temperature and *S. litura* population had a significant positive association (maximum and minimum). The population of *S. litura*, on the other hand, exhibited a weak negative connection with minimum relative humidity and a strong negative correlation with maximum relative humidity. Work has also been done on Patait *et al.* (2008) and Mishra *et al.* (2018).

CONCLUSION

The population of different insect had appeared in different crop stage like, diamondback moth first look in the final week of November, expanded gradually, and peaked in the 1st SMW. The larval populations of DBM, tobacco caterpillars, and green semiloopers all demonstrated a strong significant negative association with maximum and minimum temperatures, indicating that when the temperature changes, so does the population. While DBM and the tobacco caterpillar showed a non-significant negative connection with morning and evening relative humidity. The population of green semiloopers began to appear in the 50th SMW and peaked in the 3rd SMW. The morning and evening relative humidity have a non-significant positive connection with the green semilooper population, which indicates that as the relative humidity rises, the pest population falls. The last week of November saw the first appearance of the tobacco caterpillar larvae, and from there, the population grew steadily until it peaked in the final week of December.

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