Incidence of Major insect pests and its natural Enemies of Cabbage (*Brassica oleracea var. capitata*) under field conditions

ABSTRACT

The research was conducted in the field during the *rabi* season of 2022-23 at the Horticultural Polyhouse, College of Agriculture, Rajendranagar. The highest infestation of aphids occurred in the last week of November (48th SMW), while lepidopteran pests (leaf webber, DBM, and tobacco caterpillar) reached their peak in January (3rd, 2nd, 1st SMW, respectively) under field conditions. The average populations of Coccinellids, syrphids, and spiders were 0.80, 0.21, and 0.03, respectively. Correlation analyses revealed that aphids showed a non-significant correlation withweather parameters, displaying positive correlations with minimum temperature, RH I & II, and negative correlations with maximum temperature, rainfall, sunshine, wind, and evaporation. Leaf webber and DBM exhibited a non-significant positive correlation with maximum temperature, RH I & II, and rainfall, while showing a non-significant negative correlation with sunshine and wind speed. They also demonstrated a significant negative correlation with evaporation. For tobacco caterpillar and semilooper, a non-significant positive correlation was observed with maximum and minimum temperatures.

Keywords: Cabbage, Open field, Insect pests, Correlation, Natural enemies, Standard meteorological week.

1. INTRODUCTION

Cabbage has its origins in the Mediterranean region and was introduced to India during the Mughal era (Das, 1992; Khalid, 2006). Over time, it has become one of the most significant and popular winter vegetable crops cultivated throughout India, now grown year-round due to its high commercial value. In the 2020-21 season, India produced 9.60 million tonnes of cabbage from 4.12 lakh ha of land, with an average yield of 23.27 MT per ha. Major cabbage-producing states include West Bengal, Uttar Pradesh, Orissa, Bihar, Assam, Maharashtra, and Karnataka. In Telangana, cabbage is cultivated on 820 ha, yielding 27,780 tonnes per ha and a productivity of 33.71 tonnes per ha (Indiastat.com, 2020-21). Abhijith *et al*. (2019) highlighted the diamondback moth *Plutellaxylostella* (Linnaeus) as the primary pest, with destructive potential ranging between 14 and 84 per cent. Other lepidopteran pests, such as the cabbage butterfly (*Pieris brassicae* Linnaeus), cabbage semilooper (*Trichoplusiani Hubner*), tobacco caterpillar (*Spodoptera litura* Fabricius), cabbage head borer (*Hellulaundalis* Fabricius), and cabbage leaf webber (*Crocidolomiabinotalis* Zeller), cause extensive damage. Additionally, sucking pests like cabbage aphid (*Brevicornyebrassicae* Linnaeus), green peach aphid (*Myzuspersicae* Green), and painted bug (*Bagradacruciferum* Burmeister) have been reported to cause significant harm.Climate extremes pose challenges to vegetable cultivation, affecting crops like capsicum, cucumber, tomato, hot pepper, okra, cauliflower, cabbage, and leafy vegetables. Factors such as poor soil moisture and high temperatures contribute to lower yields, exacerbated by the impact of climate change. The vulnerability of these vegetables to biotic pressures, particularly during wet and winter seasons, further complicates successful field cultivation.

2. MATERIAL AND METHODS

The field experiment was conducted during the *rabi* season of 2022-23 at the Horticultural Polyhouse, College of Agriculture, Rajendranagar. The experimental site is positioned at an altitude of 542.3 m above mean sea level, with coordinates of 17.3850° N latitude and 78.4867° E longitude, falling within a semi-arid tropical climate. The following section outlines the materials utilized and the methodology adopted for the investigation during the course of the experiments.

2.1 Layout of Experiment:

For the planned experiment, seedlings of the cabbage variety INDU SEMINIS were cultivated in a nursery located at the Horticultural Garden. The nursery trays were filled with a mixture of vermicompost and Farm Yard Manure (FYM). The seeds were planted in the nursery trays on October 12, 2022, and the trays were irrigated once every two days. Fertilizer (19:19:19) at a rate of 2g per liter was applied every 10 days. Germination was observed within 5-6 days of sowing. Subsequently, the cabbage seedlings were transplanted into beds with a spacing of 45 cm x 30 cm on November 10th and 11th, 2022, in the field.

2.2 Observations:

2.2.1 Major insect pests:

For recording incidence of insect pests and their natural enemies, 25 plants were selected at weekly intervals. The observations recorded for the various pests are as follows

a) **Aphids:** Total number of aphids/inch^2/ 3 leaves/plant (upper, middle, lower) were counted visually with the help of magnifying lens at weekly interval(Lal 1998).
b) **Painted bug:**Number of bugs per plant
c) **Leaf webber, diamondback moth and tobacco caterpillar:**Number of larvae per plant
d) **Predators (Lady bird beetles/Syrphids/Spiders):**Number per plant

2.2.2 Meteorological data: Temperature and relative humidity were monitored in the open field, including the recording of maximum and minimum temperatures (℃), relative humidity (%), rainfall (mm), and sunshine duration (hrs). These weather parameters were correlated with the seasonal occurrence of insect pests affecting cabbage and the complex of their natural enemies. The data for weather parameters were sourced from the Agro Climatic Research Centre at PJTSAU, Rajendranagar, and then analyzed for correlations with the incidence of insect pests and their natural enemies.

2.3 Statistical analysis: Population data of major insect pests and natural enemies of cabbage thus obtained were subjected to statistical analysis to find out the coefficient of correlation with maximum and minimum temperature and morning and evening relative humidity, rainfall and sunshine hours. A simple correlation was worked out between the populations of major insect pests (aphids, Leaf webber, tobacco caterpillar and diamond back moth) with abiotic environmental factors using the following formula

$$\text{Correlation 'r'} = \frac{\sum xy - \frac{\sum x . \sum y}{n}}{\sqrt{\left\{\sum x^2 - \frac{(\sum x)^2}{n}\right\}\left\{\sum y^2 - \frac{(\sum y)^2}{n}\right\}}}$$

Where,
r = Simple correlation coefficient
x = Independent variable *i.e.,* abiotic component
y = Dependent variable *i.e.,* mean number of insect pests
n = Number of observations

Test of significance of correlation coefficient

$$t = \frac{r}{\sqrt{(1-r^2)}} \sqrt{n-2}$$

Where,
The value of 't' is based on (n-2) degrees of freedom.
n = the number of sets of observations
r = correlation coefficient

3. RESULTS AND DISCUSSION

In the present study the crop was found to be infested with aphid, cabbage leaf webber, diamondback moth, tobacco caterpillar, green semilooper and painted bug. The observations recorded on the incidence of major insect-pests and natural enemies are presented below.

3.1 Aphids:

In 2022-23, the infestation of aphid in field initiated in the second week of November (45th SMW) wherein 10.51 aphids/inch^2/3 leaves/plant were recorded which gradually increased, reaching a peak population of 29.70 aphids/inch^2/3 leaves/plant during 48th SMW, thereafter the population decreased till the end of February (8th SMW). The mean aphid incidence was recorded as 8.08 aphids/ inch^2/3 leaves/plant (Table.1).

The correlation studies showed that the aphid population aphid population showed significant negative correlation with maximum temperature (r=-0.543) and non-significant positive correlation with evening relative humidity (r=0.270), minimum temperature (r =0.440) and morning relative humidity (r=0.371) and non-significant negative correlation with rainfall (r=-0.147) evaporation (r=-0.195) and sunshine (r=-0.195) (Table.2).

3.2 Leaf webber, *Crocidolomiabinotalis Z.*

The leaf webber larvae appeared in field conditions, the leaf webber infestation was noticed in November (47th SMW) with a mean population of 0.15 larvae/plant. The larval population increased gradually and reached at a peak of 4 larvae/plant 3rd SMW and gradually decreased until harvest. The mean leaf webber incidence was recorded as 1.28 larvae/plant (Table.1).

The correlation studies showed that the Leaf webber population had significant negative correlation with evaporation (r=-0.523) and non-significant negative correlation with sunshine (r=-0.046), minimum temperature (r =-0.322), and wind speed (r=-0.335) and non-significant positive correlation with maximum temperature (r =0.200), morning relative humidity (r=0.329) and evening relative humidity (r=0.189), rainfall (r=0.044) (Table.2).

3.3 Diamondback moth, *Plutellaxylostella* L.

The diamondback moth appeared in November (48th SMW) with a mean population of 0.17 larva/plant which gradually increased and reached peak of 2.00 larvae/plant in the second week of January (2nd SMW). Thereafter, the population started declining. The mean diamondback moth incidence was recorded as 0.65 larvae/plant (Table.1).

The correlation studies showed that diamondback moth larval population had significant negative correlation with evaporation (r=-0.592) and non- significant negative correlation with sunshine (r=-0.275), wind speed (r=-0.466) and minimum temperatures, respectively; (r =-0.070) and non-significant positive correlation with maximum temperature (r =0.158), morning relative humidity (r = 0.496), evening relative humidity (r =0.408) and rainfall (r=0.103) (Table.2).

3.4 Tobacco caterpillar*, Spodoptera litura* F.

The tobacco caterpillar larvae initiated from first week of November (45th SMW) with initial population of 0.12 larvae/plant and the population increased gradually and touched its peak of 2.50 larvae/plants during first week of January (1st SMW)Thereafter, pest population reduced gradually. The mean tobacco caterpillar incidence was recorded as 0.87 larvae/plant(Table.1).

The correlation studies showed that tobacco caterpillar larval population showed significant positive correlation with morning relative humidity (r =0.633) and evening relative humidity (r =0.557) and significant negative correlation with evaporation (r=-0.521), while it showed non-significant positive correlation with maximum and minimum temperature (r =0.002and r =0.220), and rainfall (r=0.209) and non-significant negative correlation with sunshine (r=0.458) and wind speed (r=-0.410) (Table.2).

3.5 Other insect pests

The painted bugs were noticed from third week of December (51st SMW) with mean population 0.07 bugs/plant. The mean painted bug incidence was recorded as 0.01 bugs /plant and cabbage semilooper was noticed from last week of November (48th SMW) with initial population 0.17 larvae/plant increased and reached at peak of 1.0 larvae /plant during 2nd SMW (Table.1).

The correlation studies showed that cabbage semilooper larval population had significant negative correlation with evaporation (r=-0.488) and non-significant positive correlation with maximum and minimum temperature (r =0.146 and r =0.101), morning relative humidity (r = 0.396) and evening relative humidity (r = 0.418). Painted bug population had significant positive correlation with morning relative humidity (r =0.722), evening relative humidity (r =0.512) and rainfall (r=0.650). Whereas it showed non-significant positive correlation with minimum temperature (r =0.345), and non-significant negative correlation with evaporation (r=-0.248) (Table.2).

3.6 Ladybird beetle (Grubs and adults)

The ladybird beetle (grubs and adults) were first noticed in second week of November (45th SMW) with a mean population of 0.15/plant, and reached peak of 2.21/plant during December (49th SMW). Thereafter, the population reduced gradually up to the harvest. The mean ladybird beetle was recorded as 0.80 adults/plant (Table.1).

The correlation studies showed that Ladybird beetle population had non-significant positive correlation with minimum temperature (r =0.384), morning relative humidity (r =0.221) and evening relative humidity (r =0.408) and rainfall (r=0.390). The correlation studies revealed that the ladybird beetle population had significant positive correlation with aphid population (r =0.591) (Table.2).

3.7 Syrphids

The syrphids were noticed from fourth week of November (47th SMW) with a 0.03/plant, and the incidence touched its peak with a mean of 1.00/plant, during third week of December (51st SMW) Thereafter, the population reduced gradually up to the harvest. The mean syrphid population of 0.21 larva/plant was observed (Table.1).

The correlation studies showed that syrphids population had non-significant positive correlation with minimum temperature (r =0.385), while showing significant positive correlation with morning relative humidity (r =0.720), evening relative humidity (r =0.745) and rainfall (r=0.690). Syrphids show significant negative correlation with sunshine (r= -0.678), and evaporation (r=-0.507). The correlation studies revealed that the syrphids population had non-significant positive correlation with aphid population (r =0.226) (Table.2).

3.8 Spiders

The spiders were noticed from November (45th SMW) with a 0.03/plant, and the incidence touched its peak with a mean of 0.15/plant, during fourth week of December (52nd SMW) Thereafter, the population reduced gradually up to the harvest. The mean spider population of 0.03/plant was observed (Table.1).

The correlation studies showed that Spiders had non-significant negative correlation with maximum temperature (r =-0.246), while showing non-significant positive correlation with minimum temperature (r=0.064), morning relative humidity (r =0.146), evening relative humidity (r =0.195) and rainfall (r=0.394) and non-significant negative correlation with sunshine (r=-0.202), windspeed (r=-0.085) and evaporation (r=-0.147) (Table.2).

3.9 Egg parasitioids

The number of parasitized eggs were 180 during 1st interval and 350 and 290 eggs during 2nd and 3rd intervals out of total placed 10,000 eggs placed during each interval (Table.3).

Table.1 Incidence of major insect pests of cabbage in open field

Standard meteorological week (SMW)	Month	*Mean insect population						Natural enemies		
		Aphids (inch^2 /3 leaves/plant)	Leaf webber (no./ plant)	DBM (no./plant)	Tobacco caterpillar (no./plant)	Semilooper (no./plant)	Painted bug (no./ plant)	Coccinellids (no./plant)	Syrphid (no./ plant)	Spiders (no./plant)
45	05 Nov-11 Nov	10.51	0.00	0.00	0.12	0.00	0.00	0.15	0.00	0.03
46	12 Nov-18 Nov	16.97	0.00	0.00	0.14	0.00	0.00	0.27	0.00	0.07
47	19 Nov- 25 Nov	20.63	0.15	0.00	0.23	0.00	0.00	2.00	0.03	0.00
48	26 Nov- 02 Dec	29.70	0.30	0.17	0.59	0.17	0.00	1.35	0.07	0.00
49	03 Dec- 09 Dec	18.23	0.60	0.47	0.96	0.10	0.00	2.21	0.45	0.05
50	10 Dec- 16 Dec	4.57	0.90	0.66	1.05	0.10	0.00	1.10	0.30	0.07
51	17 Dec- 23 Dec	3.33	1.50	0.90	1.50	0.15	0.07	2.00	1.00	0.10
52	24 Dec- 31 Dec	5.93	2.00	1.10	2.00	0.21	0.03	1.03	0.60	0.15
1	01 Jan- 07 Jan	3.80	2.50	1.80	2.50	0.80	0.07	0.53	0.30	0.00
2	08 Jan- 14 Jan	3.43	3.00	2.00	2.40	1.00	0.00	0.20	0.60	0.00
3	15 Jan- 21 Jan	3.87	4.00	1.50	0.68	0.50	0.00	0.23	0.00	0.00
4	22 Jan- 28 Jan	2.70	3.50	0.90	0.50	0.00	0.00	0.20	0.05	0.00
5	29 Jan- 04 Feb	2.20	1.00	0.30	0.47	0.21	0.00	0.23	0.00	0.00
6	05 Jan- 11 Feb	1.63	0.52	0.23	0.32	0.00	0.00	0.27	0.00	0.00
7	12 Feb- 18 Feb	1.12	0.35	0.17	0.23	0.11	0.00	0.23	0.00	0.00
8	19 Feb- 25 Feb	0.60	0.23	0.15	0.21	0.00	0.00	0.19	0.00	0.05
	Mean	**8.08**	**1.28**	**0.65**	**0.87**	**0.21**	**0.01**	**0.80**	**0.21**	**0.03**

Table.2 Correlation of insect pests in cabbage and natural enemies with abiotic factors in open field

Abiotic/ Biotic factors	Insect Pests						Natural enemies		
	Aphids	Leaf webber	DBM	Tobacco caterpillar	Semiloo per	Painted bug	Coccinellids	Syrphids	Spiders
Maximum Temperature (^{0}C)	-0.543	0.200	0.158	0.002	0.146	-0.141	-0.471	-0.276	-0.246
Minimum Temperature (^{0}C)	0.440	-0.322	-0.070	0.220	0.101	0.345	0.384	0.385	0.064
RH 1 (%)	0.371	0.329	0.496	0.633**	0.396	0.722**	0.221	0.720**	0.146
RH 2 (%)	0.270	0.189	0.408	0.557*	0.418	0.512*	0.408	0.745**	0.195
Rainfall (mm)	-0.147	0.044	0.103	0.209	-0.053	0.650**	0.390	0.690**	0.394
Sunshine (hrs)	-0.195	-0.046	-0.275	-0.458	-0.275	-0.407	-0.381	-0.678**	-0.202
Wind speed (Km/hr)	-0.039	-0.335	-0.466	-0.410	-0.435	-0.1	0.001	-0.142	-0.085
Evaporation (mm)	-0.195	-0.523*	-0.592*	-0.521*	-0.488	-0.248	-0.225	-0.507*	-0.147
Aphids							0.591*	0.226	

*** Significant at 5% level**

****Significant at 1% level**

Table.3 Number of parasitized eggs as per data recorded using sentinel card

Date of release	Total no. of sentinel strips	Total no. of eggs	Released strips and parasitized eggs data		
			Open field		
			No. of strips released	Eggs/each stripe	Mean no. of parasitized eggs
21/11/2022	18	20,000	9	1100 (approx..)	180
10/12/2022	18	20,000	9	1100 (approx..)	350
29/12/2022	18	20,000	9	1100 (approx..)	290

The current study's findings align with Lal *et al*. (2020) observations, indicating that aphids, painted bugs, and the diamondback moth were the predominant insect pests affecting cabbage crops in both years, with tobacco caterpillars also documented. The mean peak populations of these primary insect pests were observed during the months of February and March. Aiswarya *et a*l. (2018) similarly noted varying larval populations of the tobacco leaf-eating caterpillar, leaf webber, cabbage semilooper, and DBM during their study. During the 47th SMW, the incidence of DBM, leaf webber, and cabbage semilooper initiated, while tobacco caterpillar incidence occurred during the 46th SMW. In the 2016-17 season, the 51st, 3rd, 48th, 49th, and 50th SMW witnessed the highest incidence of DBM, leaf webber, cabbage semilooper, and tobacco leaf-eating caterpillar, respectively. Bhagat *et al*. (2018) reported that diamondback moth infestation began in late December in 2015-2016 and the first week of January in 2016-2017, peaking in March for both years. Mane *et al*. (2021) observed DBM incidence starting in the second week of February, peaking in the first week of March, and gradually decreasing in the subsequent meteorological weeks. Sharma *et al*. (2022) noted that both the ladybird beetle (*Coccinellaseptempunctata*) and the cabbage aphid (*Brevicorynebrassicae*) were visible from the 49th SMW to the 8th SMW, with peak incidences occurring in the 5th SMW (41.0 larva/plant) and 4th SMW (1.0 larva/plant), respectively. According to Bhede (2018), syrphid populations peaked in the first SMW (5.75/plant) and 52nd SMW (3.55/plant) during the 2015-16 and 2016-17 seasons, respectively. Syrphids exhibited a strong inverse relationship with the lowest temperature during the first season and a substantial inverse relationship with aphids during both seasons.Mane*et al*. (2021) reported a non-significant negative correlation between DBM and maximum temperature, minimum temperature, morning humidity, and bright sunshine hours. Khan and Talukder (2017) investigated the influence of weather factors on the abundance and population dynamics of *S. litura* and *P. brassicae* on cabbage, finding that the peak larval population of *S. litura* (1.57 larvae/plant) and *P. brassicae* (1.98 larvae/plant) occurred during the 5th SMW. Meanwhile, Jemimah (2021) reported that coccinellids and syrphids exhibited a negative correlation with maximum and minimum temperatures and wind speed, while showing a positive correlation with morning relative humidity and evaporation.

4. CONCLUSION

The investigation focused on assessing the prevalence of key insect pests affecting cabbage in field conditions. This research aims to contribute to the development of a comprehensive schedule for the efficient control of major insect pests affecting the crop. The study identified common occurrences of aphids, leaf webber, tobacco caterpillar, and diamondback moth. Additionally, natural enemies such as Ladybird beetles, Syrphids, and Spiders were monitored, with their populations showing fluctuations throughout the crop growth period.

ETHICAL APPROVAL

This article does not contain any studies with human participants or animals performed by any of the authors

DEFINITIONS, ACRONYMS, ABBREVIATIONS

SMW: Standard Meterological Week

Rh1: Morning Relative Humidity

Rh2: Evening Relative Humidity

MT: Metric Tonnes

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APPENDIX

Weather data during the crop growth period in Open field (10/11/22 to 25/02/23).

Standard week	Date & Month	Temperature (°C)		R.H (%)		Rainfall (mm)	Wind speed (Km/hr)	Sunshine (hrs)	Evaporation (mm)
		Max	Min	I	II				
44	29 Oct -04 Nov	27.6	16.9	80.2	38	0	3	8.2	3.4
45	05 Nov-11 Nov	27.9	16.8	79.5	39	0	3	8.4	3.3
46	12 Nov-18 Nov	28	17	82.3	36	0	3.3	8.8	3.7
47	19 Nov-25 Nov	28.5	17.5	77.9	47.4	0	3.1	5	2.9
48	26 Nov-02 Dec	29.6	13.9	85.9	39.7	0	2	7.9	3.1
49	03 Dec-09 Dec	29.1	15.4	80.7	37.4	0	2.9	5.7	2.8
50	10 Dec-16 Dec	27.4	18.6	97.1	63.9	0.5	3.6	3.6	2.7
51	17 Dec-23 Dec	29.6	13.8	87.1	37	0	2.4	8.3	3.1
52	24 Dec-31 Dec	30.7	16.1	91.6	41.5	0	2.1	7.7	3.2
1	01 Jan-07 Jan	29.9	17.1	89	54.3	0	2.6	5.6	2.6
2	08 Jan-14 Jan	30.1	11.2	79.9	35.7	0	2.2	8.7	2.3
3	15 Jan-21 Jan	30.7	13.3	84.7	30	0	3.1	9.1	3.5
4	22 Jan-28 Jan	29.7	14.1	85.6	31.4	0	4	9	3.8
5	29 Jan-04 Feb	29.8	14.6	85.6	35.1	0	3.8	7.6	3.6
6	05 Feb-11 Feb	32.4	14.4	87.7	27.1	0	2.3	8.8	4.2

7	12 Feb-18 Feb	33.2	11.7	74.6	17.4	0	3	10.1	4.8
8	19 Feb-25 Feb	33.9	14.5	77.7	22.9	0	2.6	9.2	4.8
Total		508	256.9	1427.1	633.8	0.5	49	131.7	57.8
Mean		29.8	15.11	83.94	37.28	0.029	2.88	7.74	3.4