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Mohammed Isaq
Department of Agricultural Entomology, University of Agricultural Sciences, Raichur, Karnataka, India

Shivaleela
Assistant Professor, Department of Agricultural Entomology, University of Agricultural Sciences, Raichur Karnataka, India

Prabhuraj A
Professor and Head (PRFQAL), Department of Agricultural Entomology, University of Agricultural Sciences, Raichur Karnataka, India

Arunkumar Hosamani
Professor and Head (Biocontrol), Department of Agricultural Entomology, University of Agricultural Sciences, Raichur Karnataka, India

Pampanna Y
Associate Professor, Department of Horticulture, University of Agricultural Sciences, Raichur Karnataka, India

Corresponding Author:
Mohammed Isaq
Department of Agricultural Entomology, University of Agricultural Sciences, Raichur, Karnataka, India

Seasonal incidence of major insect pests of cabbage (*Brassica oleracea* var. *capitata*) at Raichur

Mohammed Isaq, Shivaleela, Prabhuraj A, Arunkumar Hosamani and Pampanna Y

Abstract
Studies on seasonal incidence of major insect pests of cabbage was carried out during *rabi* season, 2021-2022 at Main Agricultural Research Station, College of Agriculture, UAS, Raichur. The results revealed that peak activity of diamond back moth was (4.4 larvae/ plant) during the 2nd week of December (SMW 50), tobacco caterpillar population gradually increased and reached the peak (2.4 larvae/plants) during the last week of December (SMW 52), whereas beet armyworm, population noticed on 1st week of November (SMW45) and reached peak (1.5 larvae/ plant) in the last week of November (SMW 48), leaf Webber appeared during the 2nd week of November (SMW 46) and reached peak (11.2 larvae/plant) on 1st week of January. Whereas, population of aphids reached peak with 130.6 aphids/ plant on 52nd SMW. Correlation studies revealed that evening relative humidity (r= -0.665*) and minimum temperature (r = -0.680*) had significant and negative correlation on the larvae of tobacco caterpillar population. However, minimum temperature (r = -0.621*) had a significant negative influence on leaf Webber larvae population. Aphids population had a significant and negatively correlated with evening relative humidity (r= -0.640*) and minimum temperature (r = -0.692*).

Keywords: Seasonal incidence**,** cabbage, diamondback moth, beet armyworm, weather

Introduction
Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most important cruciferous winter vegetables grown extensively in tropical and temperate regions of the world. Structurally, cabbage has a short-thickened stem surrounded by a series of overlapping expanded leaves which form a compact head. It is native to the coastal area of Western Europe, the Northern shores of the Mediterranean region and Great Britain. Cabbage provides many health benefits. Cabbage is rich in various phyto-nutrients and vitamins like A, C and K, all are natural antioxidants, which helps to prevent cancer and heart disease-inducing free radicals. Cabbage is used as salad, boiled vegetables and dehydrated vegetables as well as in cooked curries and pickles. Cabbage cultivation covers about four per cent of the total area under vegetables in India. In Karnataka cabbage is grown on 10.07 thousand hectares with an annual production of 212.68 thousand tons with productivity of 21.11 MT/ ha (www.indiastat.com, 2022). India comes next to China in cabbage production. It is grown almost throughout the year. Orissa, West Bengal, Bihar, Karnataka, Maharashtra, Gujarat and Punjab are the major cabbage-growing states. The losses due to insect infestation or merely their presence affect the quality and market value of the vegetables very adversely which are more important than the yield loss. One of the obstacles to the low productivity of cabbage is that it suffers from complex insect pests attack from nursery to harvesting stage and can reduce more than 50 per cent yield in some cabbage genotypes (Bhat *et al.*, 1994) [2].

Lepidopteran larvae are the most destructive pests of cabbage and are often controlled with insecticides. Although some lepidopteran pests, such as diamondback moth, *Plutella xylostella* Linnaues (Lepidoptera: Plutellidae); cabbage butterfly, *Pieris brassicae* Linnaues (Lepidoptera: Pieridae), cabbage semilooper, *Thysanoplusia ni* Hubner, tobacco caterpillar, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae), Cabbage head borer, *Hellula undalis* Fabricius (Lepidoptera: Pyralidae), Cabbage leaf webber, *Crocidolomia binotalis* Zeller (Lepidoptera: Pyralidae) cause extensive damage yet some of pests *viz.*, Cabbage aphid, *Brevicorneae brassicae* (Linnaeus), Green Peach aphids, *Myzus persicae* (Green) (Homoptera: Aphididae) and painted bug, *Bagrada hilaris* (Homoptera: Pentatomidae) *etc.*, also inflict the economic damage (Bhatia and Verma, 1993) [3]. Kumar *et al.* (1983) [5] reported 52 per cent losses in marketable yield of cabbage due to the infestation of *Plutella xylostella* Linn.

The information on seasonal incidence has been generated by many previous workers (Sharma, 2004; Shukla and Kumar, 2004 and Wagle *et al*., 2005) [9, 10, 12] in different regions of India. The best way to overcome the pest damage is to manage the pest at its initial stage of the life cycle. This is possible if timely prediction of the occurrence of the pest can be made. However, there is rapid change in the climatic conditions. Hence, the investigation on seasonal incidence of major insect pests of cabbage and their natural enemies in relation to weather parameters was carried out, which can effectively be utilized in formulating pest management program.

Materials and Methods

A study on the seasonal incidence of major pests was carried out during *Rabi* 2021-22 on cabbage. The field study was conducted at Main Agricultural Research Station, College of Agriculture, UAS, Raichur and Karnataka. Populations of the major pests were recorded at weekly intervals from 10 randomly selected plants. Similarly, predators (coccinellids, syrphids and spiders) observation was recorded. The data collected was averaged per plant basis and was correlated with weather parameters *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall, rainy day, evaporation and sunshine hours by using SPSS software version 16.0.

Sampling methodology for recording of major pests of cabbage

SL. No.	Name of pest	Unit of expression	Sampling method	No. of samples	Frequency of observation
1	Diamondback moth	Larvae per plant	No. of larvae/ plant	10	Weekly
2	Tobacco caterpillar	Larvae per plant	No. of larvae/ plant	10	Weekly
3	Beet armyworm	Larvae per plant	No. of larvae/ plant	10	Weekly
4	Leaf Webber	Larvae per plant	No. of larvae/ plant	10	Weekly
5	Aphids	Aphids per plant	No. of aphids/ inch^2 leaf	10	Weekly

Statistical analysis

The data on the pest incidence were statistically analysed and then computed with correlation co-efficient studies to see the effect of different abiotic factors on the population of major pests.

Results and Discussion

Seasonal incidence of major insect pests of cabbage

Diamondback moth, *Plutella xylostella* Linnaues

During the cropping season of 2021-22, the diamondback moth population varied as depicted in Table 3. The population started from the second week of November (SMW 46), gradually increased and reached the peak (4.4 larvae/ plant) during the second week of December (SMW 50), having the mean temperature, mean relative humidity and sunshine hours of 24ºC, 63 per cent and 5 hrs. respectively. In the correlation study, the results revealed that none of the weather parameters had a significant effect on larval population build-up. But maximum temperature (r = -0.04), minimum temperature (r = -0.381), rainfall (r = -0.342), evening relative humidity (r= -0.268) sunshine hrs. (r = -0.011), and evaporation (r = -0.263) had a non-significant negative correlation with the incidence of diamondback moth population while morning relative humidity (r= 0.232) had non-significant positive correlation (Table 3 and 4, Fig.1).

The present findings are in confirmation with Sharma (2004) [9] recorded that the population of diamondback moth had a non-significant correlation with temperature, rainfall and relative humidity. Shyam *et al*. (2020) [11] reported that the incidence of diamondback moth, *Plutella xylostella* Linn. infesting cabbage crop revealed that the first appearance of the pest started during the second week of December and attended peak (5.8 larvae/ plant) in the last week of January (5th SMW). The correlation studies revealed that maximum (r= -0.496), minimum (r= -0.484), and average temperature (r= -0.534) had a non-significant negative correlation, while the other weather parameters showed a non-significant positive correlation with the larval population of the diamondback moth. But results are in contrast with the above findings reported by Hemchandra and Singh (2007) [4] revealed that higher temperature, lower relative humidity, lower total rainfall, longer duration of sunshine hours and higher wind speed favoured the pest population build-up and it may be due to changes in climatic condition and geographical location.

Tobacco caterpillar, *Spodoptera litura* Fabricius

The data on the incidence of the tobacco caterpillar population has been presented in Table 3. During the cropping season, the infestation began in the second week of November (SMW 46) and the population gradually increased and reached the peak (2.4 larvae/ plants) in the last week of December (SMW 52), during which the mean temperature, mean relative humidity and sunshine were 24ºC, 63 per cent and 5 hrs. respectively. The population when subjected to correlation with existing weather parameters, revealed that evening relative humidity (r= -0.665*) and minimum temperature (r = -0.680*) had significant and negative correlation on the incidence of tobacco caterpillar larvae whereas, rainfall (r = -0.426) and morning relative humidity (r= -0.378) were non-significant and negatively correlated; But maximum temperature (r = 0.378), sunshine hrs (r = 0.497) and evaporation (r = 0.393) had a non-significant and positive effect on the incidence of tobacco caterpillar (Table 3 and 4, Fig.2). The above findings are corroborated with the findings reported by Patait *et al.*, 2008 [6] wherein the population of *S. litura* was non-significant and negatively correlated with minimum temperature and evening relative humidity. Similarly, Prashant *et al.* (2007) [8] reported that population was negatively correlated with relative humidity and other parameters were non-significant. Thus, evening relative humidity and the minimum temperature had a negative and non-significant effect on the larval population.

Beet armyworm, *Spodoptera exigua* Hubner

The data on the incidence of beet armyworm population is presented in Table 3. During the cropping season, *Spodoptera exigua* infestation noticed in the first week of November (SMW 45) and the population gradually increased and reaching to a peak (1.5 larvae/ plant) in the last week of

November (SMW 48), during which the mean temperature, mean relative humidity and sunshine were 24ºC, 63 per cent and 5 hrs. respectively. The population when subjected to correlation with weather parameters, revealed that morning relative humidity (r= 0.396), evening relative humidity (r= 0.358) and minimum temperature (r = 0.293) had a non-significant and positive influence on *Spodoptera exigua* population, while maximum temperature (r = -0.508), sunshine hrs. (r = -0.377), rainfall (r = -0.119) and evaporation (r = -0.405) had a non-significant negative effect (Table 3 and 4, Fig 3).

But the above results are in contrast to the findings of Arulkumar *et al.* (2017) [1], wherein the population was significant and negatively correlated with maximum and minimum temperature, while the relative humidity exhibited a positive correlation and rainfall did not affect population build-up, it may be due to different agroclimatic region and different host availability.

Leaf Webber, *Crocidolomia binotalis* Zeller

Cabbage leaf Webber appeared first during the second week of November (SMW 46) and reached the peak (11.2 larvae/ plant) in the first week of January (Table 3). The population when subjected to correlation with weather parameters, revealed that minimum temperature (r = -0.621*) had a significant negative influence on cabbage leaf Webber larvae, whereas, evening relative humidity (r= -0.519), rainfall (r = -0.354), morning relative humidity (r= -0.012) had a non-significant negative correlation, but maximum temperature (r =0.15), sunshine hrs. (r = 0.295) and evaporation (r = 0.066) had a non-significant positive effect on cabbage leaf Webber larval population (Table 3 and 4, fig. 4).The results are in partial agreement with the finding reported by Badjena and Mandal (2005) [14] wherein insects attained the peak (25.6 larvae/ 10 plants) during the third week of January. Similarly, Patait *et al.* (2008) [6] reported that the population of *C. binotalis* was positively affected by maximum temperature and negatively by relative humidity and minimum temperature.

Cabbage aphid, *Brevicoryne brassicae* Linnaeus

Cabbage aphids (*Brevicoryne brassicae*) appeared first during the second week of November (SMW 46). The population of aphids reached the peak of 130.6 aphids/ plant in the 52nd standard week during 2021-22 (Table 3). The population when subjected to correlation with weather parameters, revealed that evening relative humidity (r= -0.640*) and minimum temperature (r = -0.692*) had a significant and negatively correlated with aphids population, whereas, rainfall (r = -0.544) and morning relative humidity (r= -0.117) had a non-significant negative correlation. But maximum temperature (r = 0.257), sunshine hrs. (r = 0.418), and evaporation (r = 0.145) had a non-significant positive effect on aphids population (Table 3 and 4, fig. 5). The above results are in line with Patel (2002) [2] reported that the maximum activity period of aphid was from December to January and the correlation studies indicated that the aphid population was affected significantly by temperature, mean rise in temperature after winter favors the multiplication of aphid population and high temperature after a second fortnight of February and onward reduced the aphid population. Whereas, other weather parameters could not affect the incidence of aphid.

Table 1: Weekly observation of cabbage pests during Rabi, 2021-22

Pest observed	Standard Meteorological Observation Weeks											
	45	46	47	48	49	50	51	52	1	2	3	4
Diamond back moth	0	1.1	2	2.7	2.9	4.4	4.3	4.2	3.4	3.4	1.8	0.8
Tobacco cutworm	0	0.1	0.2	0.2	0.2	0.6	0.7	2.4	2.2	2.2	2	1.8
Beet armyworm	0.2	0.2	0.2	1.5	0.5	0.8	0.3	0.3	0.2	0	0	0
Semilooper	0	0	0	0	0	0	0	0	0	0	0	0
Cabbage aphids	0	12.25	15.75	30.25	80.14	99.1	124.65	130.6	115.64	80.98	79.54	35.86
Flea beetles	0	0	0	0	0	0	0	0	0	0	0	0
Painted bug	0	0	0	0	0	0	0	0	0	0	0	0
Leaf webber	0	2.5	3.6	3.2	3.5	5.8	6.9	10.2	11.2	8.8	6.5	4.2

Table 2: Correlation of major pests of cabbage in relation to weather parameters at MARS field during *Rabi*, 2021-22

	Diamondback moth	Tobacco caterpillar	Beet armyworm	Aphids	Leaf Webber	Max T (⁰C)	Min T (⁰C)	Rainfall (mm)	Rainy Days	RH I (%)	RH II (%)	EVP	SS
Diamondback moth	1	0.308	0.295	0.862**	0.717**	-0.04	-0.381	-0.342	-0.352	0.232	-0.268	-0.263	-0.011
Tobacco caterpillar	0.308	1	-0.459	0.599*	0.838**	0.378	-0.680*	-0.426	-0.426	-0.378	-0.665*	0.393	0.497
Beet armyworm	0.295	-0.459	1	-0.053	-0.221	-0.508	0.293	-0.119	-0.16	0.396	0.358	-0.405	-0.377
Aphids	0.862**	0.599*	-0.053	1	0.853**	0.257	-0.692*	-0.544	-0.525	-0.117	-0.640*	0.145	0.418
Leaf Webber	0.717**	0.838**	-0.221	0.853**	1	0.15	-0.621*	-0.354	-0.355	-0.012	-0.519	0.066	0.295
Max T	-0.04	0.378	-0.508	0.257	0.15	1	-0.258	-0.33	-0.296	-0.409	-0.462	0.554	0.749**
Min T	-0.381	-0.680*	0.293	-0.692*	-0.621*	-0.258	1	0.647*	0.629*	0.575	0.910**	-0.599*	-0.596*
Rainfall	-0.342	-0.426	-0.119	-0.544	-0.354	-0.33	0.647*	1	0.995**	0.538	0.825**	-0.628*	-0.672*
Rainy Days	-0.352	-0.426	-0.16	-0.525	-0.355	-0.296	0.629*	0.995**	1	0.499	0.799**	-0.606*	-0.627*
RH I (%)	0.232	-0.378	0.396	-0.117	-0.012	-0.409	0.575	0.538	0.499	1	0.734**	-0.794**	-0.519
RH II (%)	-0.268	-0.665*	0.358	-0.640*	-0.519	-0.462	0.910**	0.825**	0.799**	0.734**	1	-0.779**	-0.758**
EVP	-0.263	0.393	-0.405	0.145	0.066	0.554	-0.599*	-0.628*	-0.606*	-0.794**	-0.779**	1	0.731**
SS	-0.011	0.497	-0.377	0.418	0.295	0.749**	-0.596*	-0.672*	-0.627*	-0.519	-0.758**	0.731**	1

Note: **. Correlation is significant at the 1% level *. Correlation is significant at the 5% level.

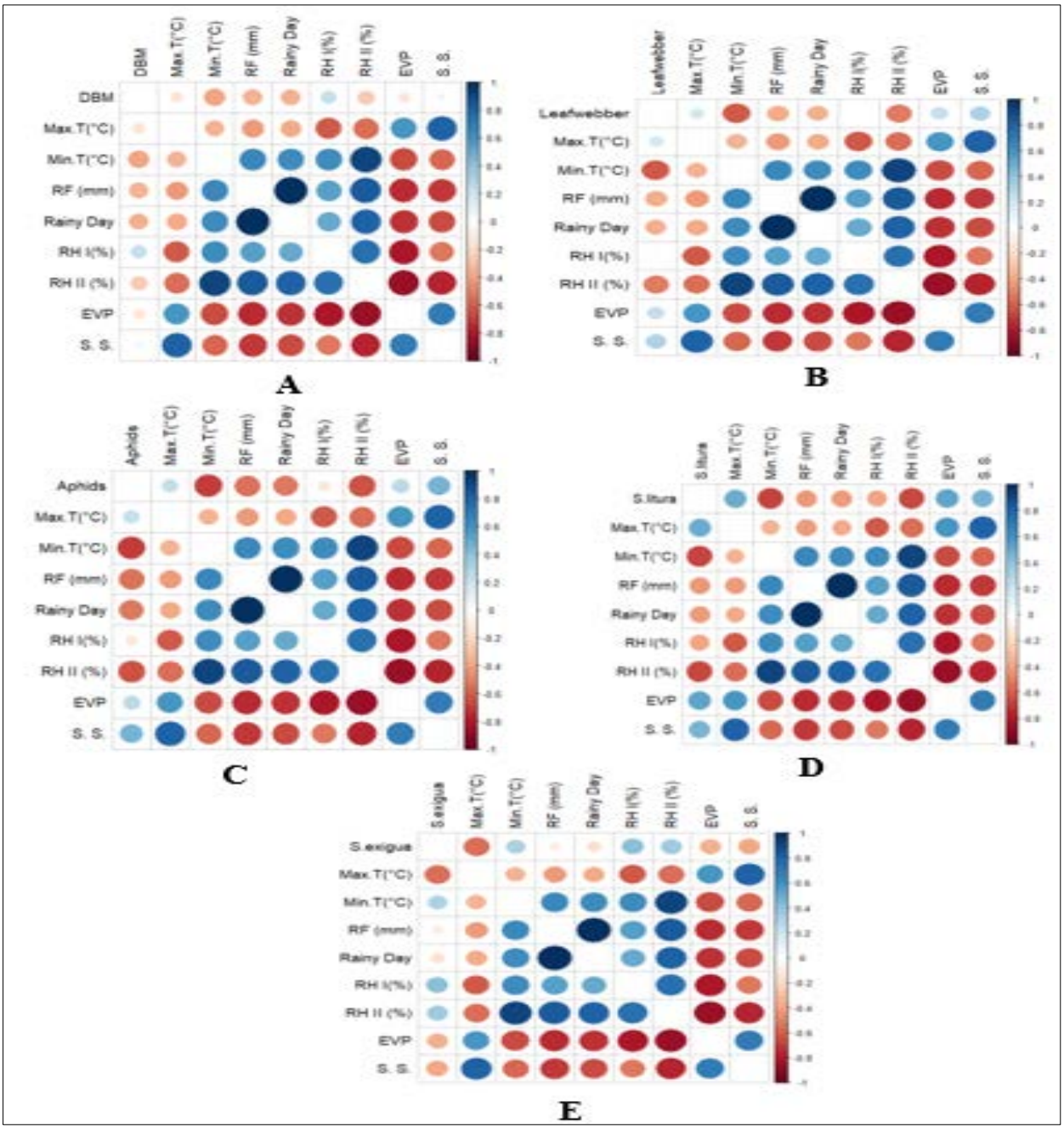

Fig 1: Heat maps depicting correlation between pests and weather parameters, a-DBM, b- leaf webber, c-aphids, d- *S. litura*, e-*S. exigua*,

Conclusion

The correlation analysis on major pests and their natural enemies of cabbage revealed that all the weather factors *viz.*, maximum, minimum temperature, rainfall, rainy day, morning relative humidity, evening relative humidity, sunshine hours and evaporation had a non-significant negative correlation with diamondback moth population. Whereas, tobacco caterpillar population was significant and negatively correlated with evening relative humidity and minimum temperature. Beet armyworm population was non-significantly correlated with weather parameters, whereas leaf Webber population was highly significant and negatively correlated with minimum temperature. Aphid population was highly significant and positively correlated with evening relative humidity and minimum temperature. These above findings can be used by the farmers for developing a sound program to counter the attack of major pests in cabbage crop to minimize losses.

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