

Seasonal Incidence of Head borer, *Hellula undalis* Fabricius and Coccinellid Predators in Cabbage and Their Correlation with Weather Parameters

ABSTRACT

The investigation was conducted to study the seasonal incidence of cabbage head borer, *Hellula undalis* Fabricius at Regional Horticultural Research Station Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India during 2021-22. The incidence of *H. undalis* on cabbage commenced from 48th Standard Meteorological Week (SMW) with its peak in the second SMW and then decreased gradually until 10th SMW, i.e., end of the crop growth period. The *H. undalis* larval population had highly significant negative correlation with maximum and minimum temperature and evaporation. There was 88.78 per cent association of the *H. undalis* population with significant weather parameters. Only coccinellid predators viz., *Coccinella transversalis* Fabricius and *Cheilomenes sexmaculata* Fabricius, were noticed in cabbage ecosystem during the crop growth period and none of the parasitoids were reported. The initial occurrence of coccinellids was noted during 48th SMW and the population increased gradually in successive weekly counts and reached the peak during second SMW and thereafter, population declined gradually until 10th SMW. The maximum and minimum temperature had significant negative correlation with the population of coccinellid beetles. The variation in abundance of coccinellids was contributed by significant abiotic factors by 85.30 per cent.

Keywords: Cabbage, coccinellid predators, *Hellula undalis*, seasonal incidence, weather parameters

1. INTRODUCTION

“India is the largest producer of vegetables after China in the world and is known as the vegetable and fruit basket” [1]. “Cabbage, *Brassica oleracea* var. *capitata*, belongs to the family Cruciferae and is widely cultivated in tropical and temperate parts of India and other parts of the world. Cruciferous vegetables have an important place among *Rabi* crops grown in India. In India, the total cultivated area of cabbage is 418 thousand hectares with the production of 9.72 million metric tons (MT) during the year 2022” [2]. Cabbage has also curative, antidiabetic, anticancerous, and anticarcinogenic properties [3]. The typical flavour in cabbage is due to glycoside “Sinigrin” which contains Sulphur [3,4]. “It is subjected to attack by a large number of insect-pests throughout its growth phase which limit the production. More than 27 species of insect-pests have been reported to infest cabbage in India” [5]. “The various pests infesting cabbage include cabbage head borer *H.*

undalis, aphids, *Lipaphis erysimi*, *Brevicoryne brassicae* Linnaeus and *Myzus persicae* Sulzer, tobacco caterpillar, *Spodoptera litura*, diamondback moth, *Plutella xylostella*, cabbage leaf webber, *Crocidolomia bionotalis*, painted bug, *Bagrada cruciferarum* and flea beetle, *Phyllotreta cruciferae*" [6- 10]. The *H. undalis* is one of the major pests infesting cabbage and distributed worldwide. It also infests other cruciferous vegetables, cauliflower, knol-khol and beetroot [11]. "The *H. undalis* caterpillars cause substantial loss by webbing the leaves and boring into stem, stalk or leaf veins. They also bore into the cabbage head making it unfit for consumption. The damage results in webbed leaf holes in cabbage head with faecal matter" [8, 12, 13]. The knowledge of the seasonal incidence of *H. undalis* and coccinellid beetles at different growth stages of cabbage will be helpful in evolving proper management schedule. However, there is scarcity of information available on the seasonal incidence of *H. undalis* and coccinellid beetles particularly in this agroclimatic zone. Keeping these facts in mind, the present investigation was undertaken seasonal incidence of *H. undalis* and coccinellid predators in cabbage ecosystem.

2. MATERIALS AND METHODS

The present investigation was carried out at Regional Horticultural Research Station Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University (NAU), Navsari, Gujarat, India during *Rabi* 2021-22. The soil of the experimental plot was clay in texture, and with pH 7.4. Geographically, Navsari is situated at 72° 54' East longitude and 20° 57' North latitude and at an altitude of 11.98 m, above the mean sea level. The climate was typically tropical and monsoonic. The average rainfall of the tract was about 1500 mm. The field was cross ploughed with a tractor drawn cultivator. It was followed by harrowing and planking to obtain a well pulverised experimental field. The weeds and crop residues, left out from the previous sown crop, were removed. Cabbage seeds of the *variety*, Golden acre, were sown in a plugged chamber in the green house. The seedlings were transplanted in 72 m² area on 11th November, 2021 with a spacing of 60 cm × 45 cm. The crop was fertilized with the recommended dose of 200:00:50 kg N, P, and K per hectare (NAU recommendation). The crop was free from the application of pesticides. Appropriate and uniform agronomical operations were followed.

The observations on numbers of *H. undalis* larvae were recorded at weekly interval since transplanting following the method developed by Mane *et al.* (2020) [13]. The observations were taken by thoroughly observing the plants and counting the numbers of larvae of *H. undalis* per plant. The numbers of coccinellid beetles were also recorded at weekly interval. The data on weather parameters viz., maximum and minimum

temperature, morning and evening relative humidity, wind speed, rainfall and sunshine hours *etc.* were obtained from meteorological observatory of NAU. The data was analyzed by simple correlation and regression analysis.

3. RESULTS AND DISCUSSION

3.1 Seasonal abundance of *H. undalis* in cabbage ecosystem

The incidence of *H. undalis* occurred from 48th SMW (2.90 larvae/plant). The larval population gradually increased and attained the peak during second SMW (5.98 larvae/plant) and then decreased to 0.37 larvae/plant at the end of the crop growth period, *i.e.*, 10th SMW. The reduction in larval population was observed from early head formation stage of cabbage (Table 1 and fig. 1).

Table 1. Seasonal abundance of *H. undalis* on cabbage since transplanting in different SMW

| Observation period | WAT | SMW | Mean larvae/plant |
|--|-----|-----|-------------------|
| 11 th – 17 th Nov | 1 | 46 | 0 |
| 18 th – 24 th Nov | 2 | 47 | 0 |
| 25 th – 01 st Dec | 3 | 48 | 2.90 |
| 2 nd - 9 th Dec | 4 | 49 | 3.35 |
| 10 th - 16 th Dec | 5 | 50 | 4.10 |
| 17 th – 23 rd Dec | 6 | 51 | 4.85 |
| 24 th - 30 th Dec | 7 | 52 | 5.20 |
| 31 st Dec – 6 th Jan | 8 | 1 | 5.67 |
| 7 th – 13 th Jan | 9 | 2 | 5.98 |
| 14 th - 20 th Jan | 10 | 3 | 5.43 |
| 21 th – 27 th Jan | 11 | 4 | 4.26 |
| 28 th Jan – 3 rd Feb | 12 | 5 | 3.75 |
| 04 th – 10 th Feb | 13 | 6 | 3.15 |
| 11 th - 17 th Feb | 14 | 7 | 2.49 |
| 18 th – 24 th Feb | 15 | 8 | 1.28 |
| 25 th – 3 rd March | 16 | 9 | 0.93 |

| | | | |
|--|----|----|------|
| 4 th – 10 th March | 17 | 10 | 0.37 |
|--|----|----|------|

WAT – Week(s) After Transplanting

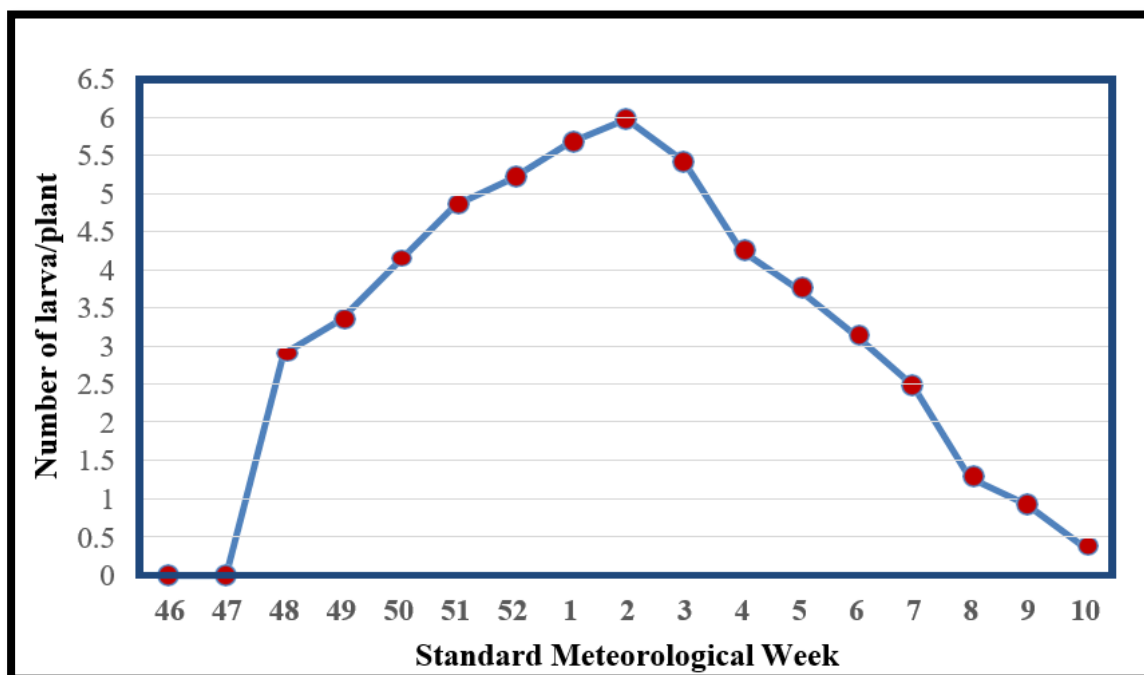


Fig. 1. Seasonal abundance of *H. undalis* infesting cabbage in different SMW

The present findings are more or less similar to those of Alam (2015) [14] who observed “the initial occurrence of larvae nearly about 18-22 days after transplanting or in 49th SMW at Varanasi”. Patel (2002) and Shukla (2002) [15, 16] observed “the initial occurrence of pests between 21-28 days after transplanting during 50th SMW at Raipur and Udaipur, respectively”. Bhagat *et al.* (2018) [17] recorded “the incidence after one month of transplanting”. The peak population of 14.09 larvae/ plant was observed by Maity *et al.* (2018) [18] on 10 WAT at West Bengal. Goud *et al.* (2006) [6] found the peak population during the last week of January *i.e.*, at 85 days after transplanting at Hyderabad. Gaikwad *et al.* (2018) [19] recorded “the maximum diamondback moth larval population of 7.82 larvae/plant in 2nd SMW in cauliflower at Parbhani”. Aiswarya *et al.* (2018) [20] revealed that “the initial population of diamondback moth larva was observed during 47th SMW with peak incidence of 5.20 larvae/plant at 51th SMW during *rabi* season at Parbhani, Maharashtra”. Mishra *et al.* (2018) [21] reported major activity period of diamondback moth on cauliflower from 35th to 39th SMW with peak incidence in 39th SMW (7.32 larvae/plant) during late-*kharif* season at Dhule. Baker *et al.* (1982) [22] reported that the mean larval populations remained below 3.0 larvae per plant in cabbage ecosystem. Oduor *et al.* (1997) [23] recorded the diamondback moth population not exceeding 6 larvae/plant.

According to Lasota and Kok (1989) [24], “the minimum larval population of 0.70 larvae/plant was observed at the end of the crop growth period during last week of February”. Harcourt *et al.* (1955) [25] recorded “the least population of diamondback moth might be due to the non-availability of hosts at the end of crop season or when the moths emerged, they were no longer attracted to cabbage as it reached harvesting maturity by then”. Venugopal *et al.* (2017) [26] recorded the minimum diamondback moth larva on second fortnight of February on cabbage at Allahabad. These findings are also concurrent with the present findings.

The *H. undalis* population exhibited highly significant negative correlation with maximum temperature ($r = -0.793$), and significant negative correlation with minimum temperature ($r = -0.572$) and evaporation (-0.542). It indicated that the rise in temperature led to decline in the larval population. The morning ($r = 0.406$) and evening relative humidity ($r = 0.422$) had nonsignificant positive correlation with the population of *H. undalis*. A comparison of temperature record with population growth suggested that daily minimum temperature ranging from 18.3 to 18.1°C and daily maximum temperature between 36.8 and 33.4°C favored insect multiplication. The absence of rain during crop growing season excluded the correlation of larval population with total rainfall (Table 2 and figure 2).

Table 2. Effect of weather parameters on population of *Hellula undalis* larvae in cabbage ecosystem

| Weather parameter | Correlation coefficient (r) |
|-------------------------------|-----------------------------|
| Maximum temperature (°C) | -0.793** |
| Minimum temperature (°C) | -0.572* |
| Morning relative humidity (%) | 0.406 |
| Evening relative humidity (%) | 0.422 |
| Wind speed (km/hr) | -0.107 |
| Sunshine hours (hrs/day) | -0.435 |
| Evaporation | -0.542* |

*Significant at the level of 0.05, **Significant at the level of 0.01

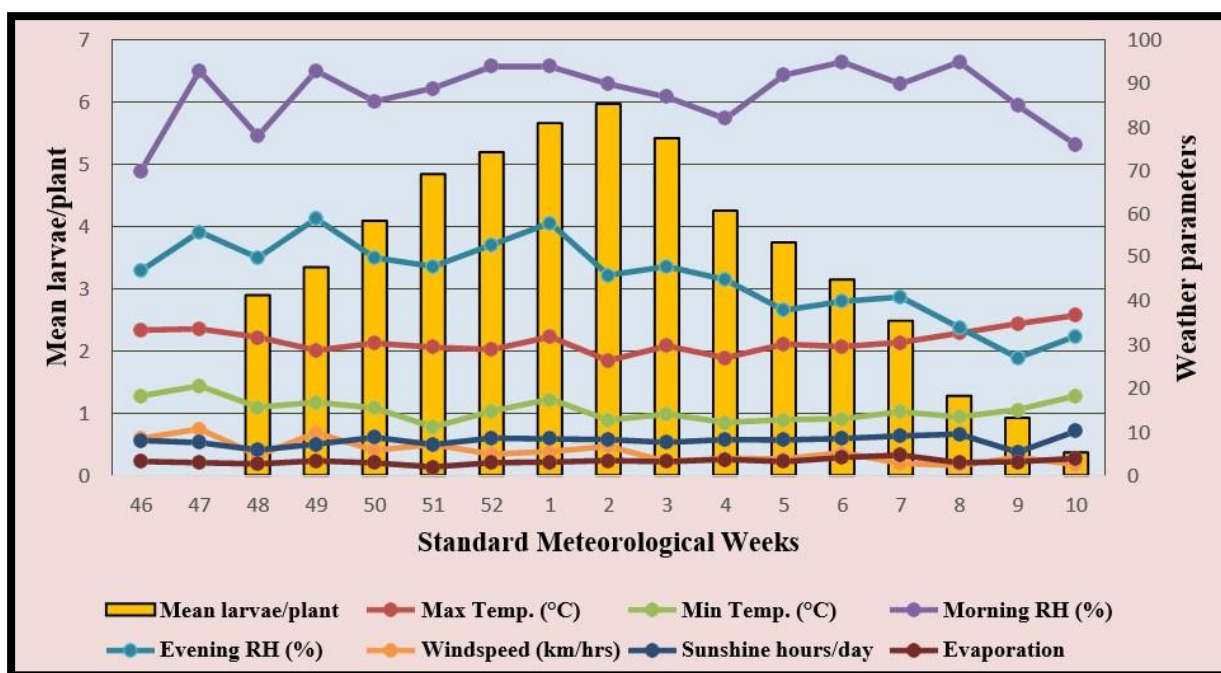


Fig. 2. Seasonal abundance of *H. undalis* in relation to weather parameters

The present findings are close to those of Usha *et al.* (1997) [27] who observed a negative correlation of larval population with maximum and minimum temperature and sunshine hours. Poonam (1999) [28] observed that larval population was significantly negatively correlated with mean and maximum temperature but positively correlated with relative humidity. Bhalla and Dubey (1986) [29] suggested that daily maximum temperature between 21 and 36°C and daily minimum temperature ranged from 5 to 12°C favored insect multiplication during crop period. The present results regarding the correlation of larval population with weather parameters are also in conformity with the findings of Bana *et al.* (2012), Shukla (2002), Sharma *et al.* (2017) and Jaishree (2017) [9, 16, 30, 31]. Venugopal *et al.* (2017) [26] showed that there was a non-significant positive correlation of sunshine hours and non-significant negative correlation of morning relative humidity with the population of *H. undalis*. There was a negative correlation of *P. xylostella* population with mean relative humidity [32]. Goud *et al.* (2006) [6] recorded a negative correlation of larval population with maximum temperature and sunshine hours and positive correlation with minimum temperature. The positive correlation of larval population with temperature was suggested by Maity *et al.* (2018), Hemchandra and Singh (2007), Patra *et al.* (2013), Jat *et al.* (2017), Jakhar and Singh (2018) [18, 33, 34, 35, 36].

“Regression studies on the effect of abiotic factors on the build-up of *H. undalis* population revealed that it was significantly influenced by weather factors like wind speed with their contribution being 88.78 per cent”. [41]

Coefficient of determination (R^2) = 0.88

Regression equation: $\hat{Y} = 7.23 - 0.39X_4$

The present findings are alike to those of Sonika *et al.* (2017) and Ahmad *et al.* (2015) [37, 38] who revealed that the *P. xylostella* population was significantly influenced by weather factors with their contribution being 77.60 and 90-98 per cent, respectively. Nagesh (1997) [39] reported that none of the weather parameters individually showed a significant correlation with diamondback moth population, yet maximum temperature, minimum temperature, relative humidity, wind speed, sunshine hours and rainfall together explained 64.93 per cent of the variation in larval population. According to Goud *et al.* (2006) [6] the cumulative effect of weather parameters on the population build-up of diamondback moth was to an extent of 28.11 per cent which is deviated from the present results. This may be due to the differences in variety, species, composition of leaf and prevailing environmental conditions.

3.2 Seasonal abundance of coccinellid beetles in cabbage ecosystem

“Among the natural enemies of insect pests of cabbage, the coccinellid predators were found in the field and none of the species was recorded parasitizing the moths. Coccinellid predators *viz.*, *Coccinella transversalis* (Fabricius) and *Cheilomenes sexmaculata* (Fabricius) were noticed in cabbage ecosystem during the course of study”. [41]

The results revealed the absence of predators for first two weeks after transplanting the crop. The initial incidence of coccinellids occurred in 48th SMW with an initial population of 0.25 adults/plant. The population increased gradually in successive weekly counts and reached the peak of 1.35 adults/plant in second SMW and thereafter, the population gradually declined to 0.30 adults/plant during the 10th SMW (Table 3 and fig 3).

Table 3. Seasonal abundance of coccinellid beetles in Cabbage ecosystem in different SMW

| Observation period | SMW | Mean Adults/plant |
|---|-----|-------------------|
| 11 th – 17 th Nov | 46 | 0 |
| 18 th – 24 th Nov | 47 | 0 |
| 25 th – 01 st Dec | 48 | 0.25 |
| 2 nd - 9 th Dec | 49 | 0.40 |

| | | |
|--|----|------|
| 10 th - 16 th Dec | 50 | 0.65 |
| 17 th - 23 rd Dec | 51 | 0.75 |
| 24 th - 30 th Dec | 52 | 0.90 |
| 31 st Dec - 6 th Jan | 1 | 1.15 |
| 7 th - 13 th Jan | 2 | 1.35 |
| 14 th - 20 th Jan | 3 | 1.05 |
| 21 th - 27 th Jan | 4 | 0.95 |
| 28 th Jan - 3 rd Feb | 5 | 0.90 |
| 04 th - 10 th Feb | 6 | 0.72 |
| 11 th - 17 th Feb | 7 | 0.48 |
| 18 th - 24 th Feb | 8 | 0.55 |
| 25 th - 3 rd March | 9 | 0.35 |
| 4 th - 10 th March | 10 | 0.30 |

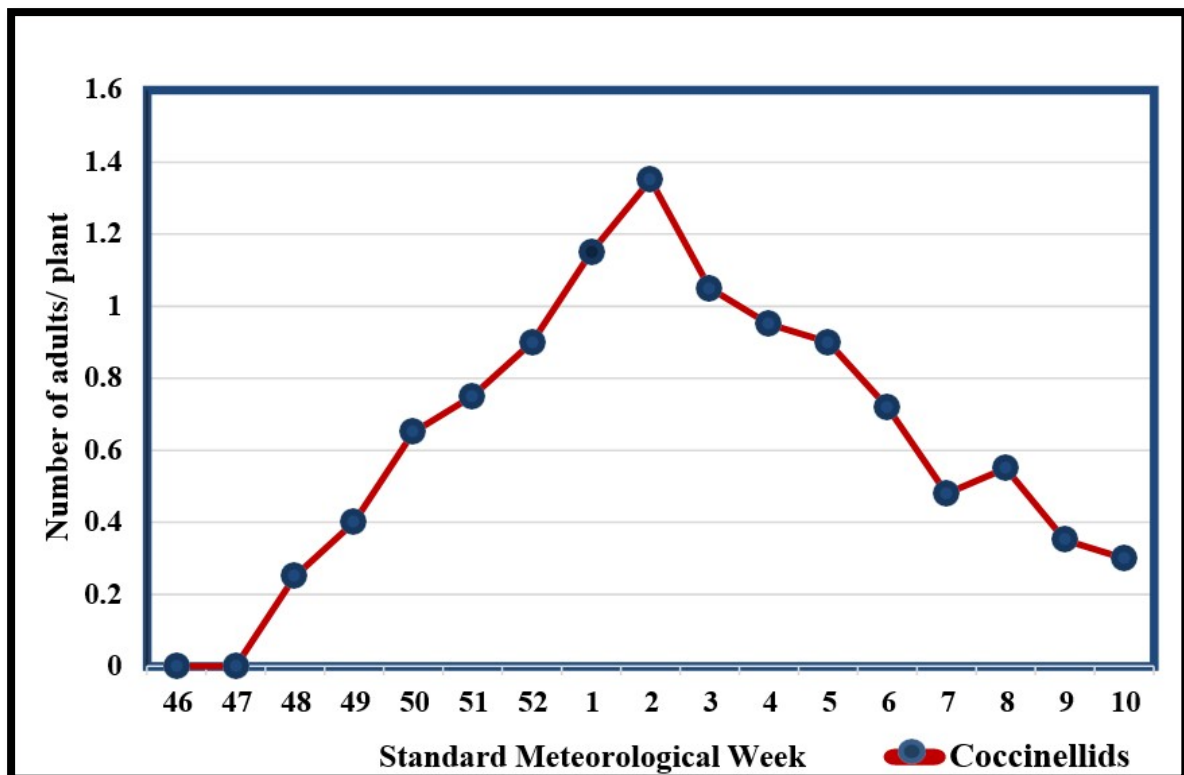


Fig. 3. Seasonal abundance of coccinellid beetles in cabbage in different SMW

Earlier, Debbarma *et al.* (2017) [40] noticed “the coccinellid predators viz., *Coccinella sexmaculata*, *Scymnus* sp., *Coccinella septempunctata* (Fabricius) and *Brumoides suturalis* (Fabricius) during the survey conducted in Dindigul and Theni districts of Tamil Nadu on cauliflower”. Jakhar and Singh (2018) [36] revealed that “the ladybird beetle, *C. septempunctata* was recorded as the major natural enemy predator in cauliflower ecosystem and the population was first noticed in the 4th SMW (8.6/ ten plants) and reached the maximum in the 11th SMW (20.2/ ten plants) at maximum and minimum temperature of 26.3 and 13.0 °C, respectively”. Sharma *et al.* (2017) [30] also recorded the presence of coccinellid predator, *C. septempunctata* as major natural enemy in the cabbage ecosystem which fed on the aphids. Jat *et al.* (2017) [35] found that the population of *C. septempunctata* touched its peak (2.10 adult/plant) during 6th SMW with initial incidence on 52nd SMW and *C. sexmaculata* was observed from first week of January to last week of February. Patra *et al.* (2013) [34] noticed the occurrence of coccinellids from seedling stage and continued till harvesting of crop. These findings are concurrent with the present findings.

The data in table 4 and fig 4 revealed that the population of coccinellid beetles had highly significant negative correlation with maximum temperature ($r = -0.692$) and minimum temperature ($r = -0.636$).

Table 4. Effect of weather parameter on population of coccinellid beetles in cabbage ecosystem

| Weather parameter | Correlation coefficient (r) |
|-------------------------------|-----------------------------|
| Maximum temperature (°C) | -0.692** |
| Minimum temperature (°C) | -0.636** |
| Morning relative humidity (%) | 0.446 |
| Evening relative humidity (%) | 0.114 |
| Wind speed (km/hr) | -0.313 |
| Sunshine hours (hrs/day) | -0.313 |
| Evaporation | -0.415 |

*Significant at the level of 0.05, **Significant at the level of 0.01

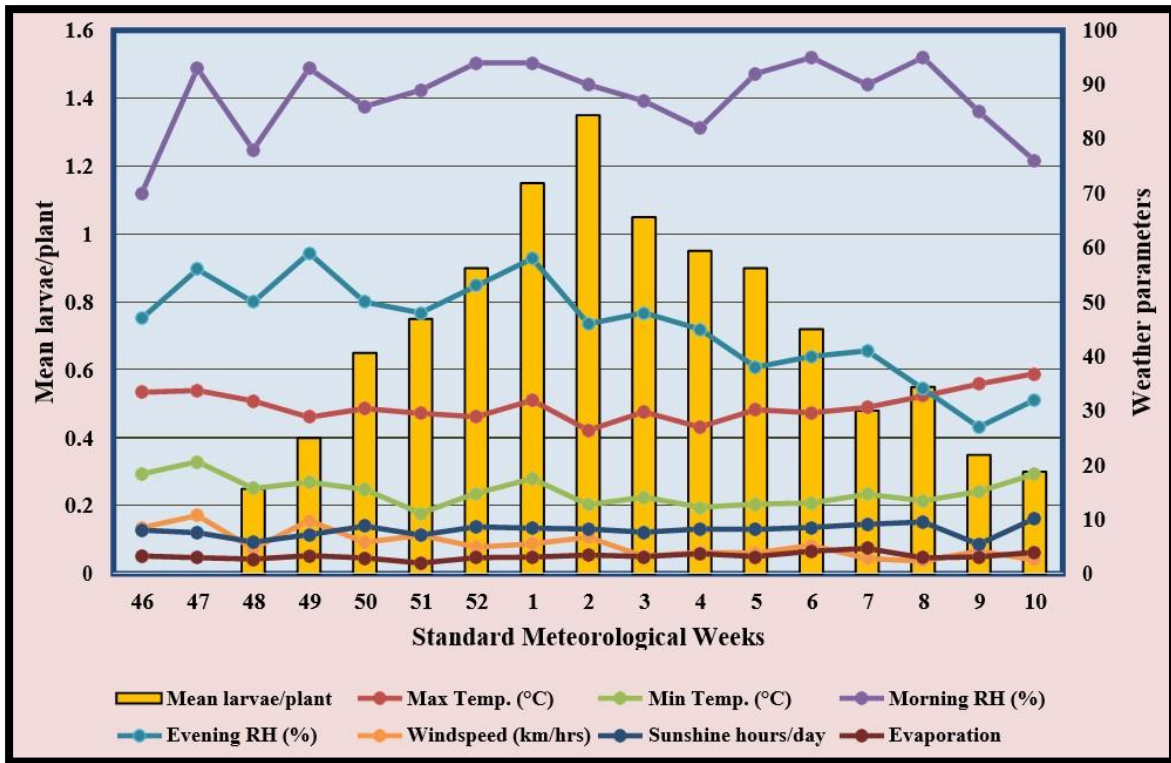


Fig 4. Seasonal abundance of *H. undalis* in relation to Temperature, Relative Humidity, Wind speed, Sunshine hours and Evaporation

Similarly, Sharma *et al.* (2017) [30] revealed that the population of *C. septempunctata* had non-significant correlation with maximum and minimum temperature, relative humidity and sunshine hours. Jhakar and Singh (2018) [41] reported that the population of *C. septempunctata* had significant positive correlation with maximum and minimum temperature ($r = 0.71$ and $r = 0.66$, respectively). Jat *et al.* (2017) [35] found that *C. sexmaculata* population exhibited a negative correlation ($r = -0.102$) with mean temperature and positive correlation with mean relative humidity ($r = 0.053$) during *rabi* season.

Regression studies on the effect of abiotic factors on the build-up of *H. undalis* population revealed that the *H. undalis* population was significantly influenced by weather factors like wind speed with their contribution being 85.30 per cent.

Coefficient of determination (R^2) = 0.85

Regression equation: $\hat{Y} = 2.46 - 0.09X_4$

4. CONCLUSION

The incidence of *H. undalis* on cabbage commenced from third week after transplantation of cabbage seedlings with its peak during early head formation stage and then decreased gradually until the end of crop growth

period. The *H. undalis* larval population had significant negative correlation with maximum and minimum temperature and evaporation. Only coccinellid predators viz., *C. transversalis* and *C. sexmaculata* were noticed in cabbage ecosystem during the crop growth period and none of the parasitoids were reported. The initial occurrence of coccinellids was noted after two weeks of transplanting and the population increased gradually in successive weekly counts and reached a peak during early head formation stage and thereafter, population declined gradually. The maximum temperature and minimum temperature had significant negative correlation with the population of coccinellid beetles. These may vary with the changing environmental conditions even in the same variety of the crop in the succeeding years.

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COMPETING INTERESTS

There are no competing interests exist.

Authors Contribution

DAB- Designed, performed, analysed and visualised the experiment, MKJ- Writing, reviewing, editing and visualisation, HVP- Supervision and visualisation. All authors have read and approved the manuscript.

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