**Population Dynamics of the Cabbage Butterfly [*Pieris brassicae* L (Lepidoptera: Pieridae)] on Broccoli in the Western Himalayan Region**

ABSTRACT

 The present investigation was carried out at the Vegetable Research Farm of the Department of Vegetable Science, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand, to study the population dynamics of cabbage butterfly on broccoli.   The standard weeks were considered as treatments. The experiment was conducted in two cropping seasons with twelve treatments and three replications. The number of eggs, larvae, number of pupae and adults of the cabbage butterfly were visually recorded at each standard week by correlating with weather parameters in two cropping seasons. During the first season (17th– 28th standard week) the eggs of the cabbage butterfly increased gradually and reached a peak level of 11.49 eggs at 24th standard week, 12.83 larvae at 23rd standard week, 10.49 pupae at 24th standard week and 1.34 adults at 23rd standard week. In the second season (37th – 48th standard week), the eggs laid by the Cabbage white butterfly increased gradually and reached a peak level of 10.49 eggs in 44th standard week, 10.56 larvae at 40th standard week, 8.48 pupa at 48th standard week and 0.48 adult at 48th standard week. The decline trend was observed due to the fall of optimum weather conditions for the cabbage butterfly.

**Keywords:** cabbage butterfly, Population dynamics, broccoli, *Pieris brassicae,* Temperature, Relative humidity, rainfall.

**1. INTRODUCTION**

            Broccoli (*Brassica oleracea* L.) is one of the most nutritious vegetables amongst the cole crops, grown for its tender heads. It is regarded as an important functional food due to its high nutritional value, i.e., vitamin A, thiamin, riboflavin, niacin, vitamin C, Ca, P, K, Fe and carotene. This nutritious vegetable crop contains an active metabolite, indole-3-carbinol which possess anti-cancerous properties (Thakur et al., 2016; Thapa and Rai, 2012; Kumar et al. 2011and Owis., 2015). China is the largest broccoli producer (10,707,171 tons/ year) followed by India (8.8 million tons/ year) (Anon., 2024). The pests which attack the broccoli are the cabbage butterfly, *Pieris brassicae*; the leaf webber, *Crocidolomia binotalis*; the leaf-eating weevil, *Tanymecus circumdatus*; the cutworm, *Agrotis ipsilon*; the termite, *Microtermes obesi*; the cabbage head borer, *Hellula undalis*; the mustard sawfly, *Athalia lugens proxima*; the painted bug. *Bagrada cruciferarum*, aphids, *Brevicoryne brassicae* and *Lipaphis erysimi*, diamondback moth, *Plutella xylostella*, whitefly, *Bemisia tabaci*, leaf miner, *Chromatomyia horticola*, tobacco caterpillar, *Spodoptera litura*, red spider mite, and *Tetranychus urticae* (Satyagopal et al, 2015). The cabbage butterfly, *Pieris brassicae* is a serious pest of cruciferous vegetables, including cabbage, cauliflower, broccoli, kale, and Brussels sprouts. This pest is widespread across Europe, Asia, and parts of North Africa, with its range expanding due to climate change and globalization of agricultural trade (Mpumi et al., 2020). In larval stage, the cabbage butterfly inflicts significant damage to the host plants, feeding on leaves and young shoots, resulting in severe defoliation. The presence of this pest has long been a challenge for sustainable agriculture due to its capacity for rapid population growth, high and multivoltinism, allowing it to complete multiple generations in a single cropping season (Saisri et al., 2022).The damage caused by the cabbage butterfly is most severe during the larval stage, when the caterpillars consume large quantities of leaf tissue. The larvae are gregarious feeders in their early stages and can skeletonize leaves within a short period, reducing the photosynthetic capacity of the plant and ultimately leading to stunted growth and reduced yield (Kumaranag et al., 2014). Globally, *Pieris brassicaeis* considered a key pest in cruciferous vegetables causes 30% to 80% yield losses depending on crop, variety and environmental conditions (Subedi et al., 2024). The severity of the incidence of insect pests is greatly influenced by the prevailing climatic conditions (Meena *et al.*, 2013). Cabbage butterfly is actively present during March to June. Incidence of cabbage butterfly is greatly influences by abiotic factors like temperature, rainfall, relative humidity and sunshine(Semwal *et al*., 2020). Limited work has been done on the population dynamics of *Pieris brassicae* in relation to weather parameters in broccoli, particularly in the western Himalayan region.

**2. MATERIALS AND METHODS**

The present investigation was carried out at the Vegetable Research Farm of the Department of Vegetable Science, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand, for the study of population dynamics of the cabbage butterfly on broccoli.The incidence and population dynamics of the cabbage butterfly larvae were visually recorded from the three leaves of the five randomly selected and tagged plants per plot by correlating the population with weather parameters. The data on the population dynamics of the cabbage butterfly is taken at a weekly interval to check the effect of different climatic factors like temperature, relative humidity, rainfall and sunshine on the population of cabbage butterflies. For the statistical analysis, standard weeks were considered as treatments. The experiment was conducted in two cropping seasons (18th April-4th July and 5th September- 21st November) and with twelve treatments and three replications.The observations on the number of eggs, larvae, pupae and adults were recorded at each standard week. Meteorological observations were collected from the meteorological observatory Bharsar. The experimental data were subjected to statistical analysis for interpretation. Least significant differences (LSD) at the 5 per cent level of significance were computed based on ANOVA following a completely randomized design (CRD), after a needful transformation of data.

**3. RESULTS AND DISCUSSION**

Results on the population dynamics of the cabbage butterfly, *Pieris brassicae,* on broccoli in the western Himalayan region showed that the occurrence of the cabbage butterfly started from the 17th standard week (Table 1). The minimum number of 3.11 eggs/plant was recorded in the 28th standard week, and the maximum number, 11.49 eggs/plant, in the 24th standard week. The maximum larval population of cabbage butterfly, 12.83 larvae/plant, was reported in the 23rd standard week. Whereas the minimum larvae, 3.46 per plant, were recorded in the 17th standard week, which was found statistically significant with all other standard weeks. The highest number of pupae, 10.49, was found in the 24th standard week, and the minimum pupal population, 1.92/plant, was observed in the 17th standard week. The highest incidence of adult population (1.89) was observed in 19th standard weeks. The minimum population of adults was 0.47, recorded in 28 standard weeks whereas the maximum temperature 15.35O C in 21st standard week and minimum 10.07 0 C were observed in 27th standard week (Figure 1). The average population of cabbage butterfly (*Pieris brassicae*) during the first season was positively correlated with temperature and sunshine hours but negatively correlated with rainfall (Table 2). This finding was confirmed by Sood and Bhalla. (1996) he reported that the population of cabbage butterflies is directly proportional to high temperature and more sunshine hours accompanied with low relative humidity and low rainfall favoured population buildup. Devi and Singh (2002) also reported that the population dynamics of *Pieris brassicae* infestation were observed throughout the year. Pest was observed from November to February in the heading stage and from March to June in the ratoon stage.

**Table 1**. **Population Dynamics of *P. brassicae* L in relation to Agro climatic condition of Bharsar during 18th April -4th July,**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Population of the indicated stage** | | | |
| **S.No** | **Standard**  **Week** | **No. of eggs** | **No. of larvae** | **No. of pupa** | **No. of adult** |
| **1** | **17** | 5.05  (2.36) | 3.46  (1.99) | 1.92  (1.56) | 0.89  (1.18) |
| **2** | **18** | 5.16  (2.38) | 4.46  (2.23) | 3.38  (1.97) | 0.69  (1.09) |
| **3** | **19** | 7.66  (2.86) | 8.32  (2.97) | 4.93  (2.33) | 1.89  (1.55) |
| **4** | **20** | 8.59  (3.01) | 8.74  (3.04) | 4.99  (2.34) | 0.68  (1.09) |
| **5** | **21** | 7.74  (2.87) | 10.39  (3.30) | 4.51  (2.24) | 0.66  (1.08) |
| **6** | **22** | 6.73  (2.69) | 11.13  (3.41) | 6.81  (2.70) | 1.09  (1.26) |
| **7** | **23** | 11.28  (3.43) | 12.83  (3.65) | 8.77  (3.04) | 1.34  (1.36) |
| **8** | **24** | 11.49  (3.46) | 12.26  (3.57) | 10.49  (3.32) | 1.10  (1.26) |
| **9** | **25** | 10.37  (3.30) | 10.88  (3.37) | 8.35  (2.97) | 0.91  (1.19) |
| **10** | **26** | 7.55  (2.84) | 9.04  (3.09) | 6.91  (2.72) | 0.69  (1.09) |
| **11** | **27** | 5.15  (2.38) | 5.14  (2.37) | 5.59  (2.47) | 0.65  (1.07) |
| **12** | **28** | 3.11  (1.90) | 4.49  (2.23) | 3.19  (1.92) | 0.47  (0.98) |
| **SE (d)** | | 0.07 | 0.04 | 0.05 | 0.01 |
| **C.D ( 0.05)** | | 0.12 | 0.07 | 0.06 | 0.03 |

Figures in parenthesis () are square root transformed value

**Figure 1. Weather graph during 17th standard week – 28th standard weeks**

**Table 2. Relationship between *Pieris brassicae* Population and Weather Parameters on Broccoli during 17th to 28th standard weeks at Bharsar condition.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Correlation co-efficient**  **Weather parameter** | **No. of eggs** | **No. of larva** | **No. of pupa** | **No. of adult** |
| **Temperature (0C)** | 0.216 | 0.354 | 0.215 | 0.530 |
| **Rainfall (mm)** | -0.512\* | -0.461 | -0.602\* | -0.651 |
| **Sunshine hours** | 0.041 | 0.178 | 0.014 | 0.523 |

\* Significance of correlation coefficient at 5% level of significance

The population dynamics of *P. brassicae* presented in Table 3 revealed that the minimum number of 1.92 eggs/plant was observed in the 37th standard week. The maximum number, 10.49 eggs/plants, was found in the 44th standard week. The occurrence of larvae of the cabbage butterfly started from the 37th standard week. The minimum larvae 3.05 /plants were recorded in the 48th standard week, which was found statistically significant with all other standard weeks. The maximum larvae/plants were recorded at 10.56 in the 40th standard week. The maximum number of pupae, 8.48, was recorded in the 44th standard week. Whereas the minimum pupal population of 2.05/plant was observed in the 37th standard weeks. The highest incidence of the adult population (1.43) was recorded in the 42nd standard weeks. The minimum population of adults was 0.48, recorded in 48 standard weeks (Table 3). The average population of cabbage butterfly (*Pieris brassicae*) was positively correlated with temperature and sunshine hours but negatively correlated with rainfall (Table 4). Semwal et al 2020, reported that population of *P. brassicae*, in 18th to 25th SMW increased from 116.67 eggs to 152.48 eggs, 110.54 to 163.21 larvae and adult population from 7.54 to 13.45 adult/10 plants. Yunus et al. (2004) also reported that the population of cabbage butterflies was highest, with an average of 86.67% larvae/plant in the first week of November, and the lowest average of 0.67% larvae/plant was recorded in the first week of December due to the fall of temperature.

**Table 3. Population dynamics of *Pieris brassicae* L in relation to agro climatic condition of Bharsar during 5th September – 21st November**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Population of cabbage butterfly/plant** | | | |
| **S.No** | **Standard**  **Week** | **No. of egg** | **No. of larva** | **No. of pupa** | **No. of adult** |
| **1** | **37** | 1.92  (1.56) | 4.46  (2.23) | 2.05  (1.60) | 0.74  (1.11) |
| **2** | **38** | 3.38  (1.97) | 4.87  (2.32) | 3.18  (1.92) | 0.96  (1.21) |
| **3** | **39** | 4.93  (2.33) | 8.34  (2.97) | 4.52  (2.24) | 0.96  (1.21) |
| **4** | **40** | 4.99  (2.34) | 10.56  (3.33) | 4.86  (2.32) | 1.34  (1.36) |
| **5** | **41** | 6.51  (2.65) | 9.63  (3.18) | 4.57  (2.25) | 1.30  (1.34) |
| **6** | **42** | 6.81  (2.70) | 9.15  (3.11) | 7.04  (2.75) | 1.43  (1.39) |
| **7** | **43** | 8.77  (3.04) | 8.56  (3.01) | 6.66  (2.68) | 1.06  (1.25) |
| **8** | **44** | 10.49  (3.32) | 7.00  (2.74) | 8.48  (3.00) | 0.85  (1.16) |
| **9** | **45** | 8.35  (2.97) | 6.26  (2.60) | 7.58  (2.84) | 0.92  (1.19) |
| **10** | **46** | 6.91  (2.72) | 5.06  (2.36) | 4.84  (2.31) | 0.77  (1.13) |
| **11** | **47** | 5.59  (2.47) | 4.15  (2.16) | 3.69  (2.05) | 0.66  (1.08) |
| **12** | **48** | 3.19  (1.92) | 3.05  (1.88) | 3.23  (1.93) | 0.48  (0.99) |
| **SE (d)** | | 0.02 | 0.02 | 0.20 | 0.02 |
| **C.D ( 0.05)** | | 0.06 | 0.04 | 0.42 | 0.05 |

Figures in parenthesis () are square root transformed value

**Table 4. Relationship between *P. brassicae* Population and Weather Parameters on Broccoli during 37th to 48th standard weeks at Bharsar condition.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Correlation co-efficient**  **Weather parameters** | **No. of eggs** | **No. of larva** | **No. of pupa** | **No. of adult** |
| **Temperature(0C)** | 0.563 | 0.5628 | 0.252\* | 0.143\* |
| **Rainfall(mm)** | -0.651 | -0.720 | -0.592 | -0.289\* |
| **Sunshine hour** | 0.567 | 0.440\* | 0.287\* | 0.172\* |

\*significant at 5% level of significance

**Figure 2: Weather parameters during 37th standard week – 48th standard weeks**

Pooled data on the population dynamics of cabbage butterflies on broccoli presented in Table 4 showed that the maximum number of 10.99 eggs/plant was recorded in the 24th and 44th pooled standard weeks. The maximum numbers of 10.70 larvae/plants in the 23rd and 43rd and 9.49 pupae/plants were observed in the 24th and 44th standard weeks. Whereas the maximum adult population (1.37) was recorded in the 23rd and 43rd standard weeks. The above-mentioned findings are in strong conformation with Ahmad et al. (2007)reported that Pieris brassicae appeared in the 43rd standard week and remained active in the field up to the 7th standard week, with the peak population (58.10 larvae per plant) in the 50th standard week. The population of Pieris brassicae was positively correlated with temperature and sunshine and negatively with rainfall. Singh and Sandhu (2016) reported that the occurrence of the cabbage butterfly (Pieris brassicae) on cole crops and reported that after 11 weeks of transplanting (9th September), the larval population reached its peak with an average population of 1.88 larvae/plant, and this population was directly proportional to temperature and sunshine hours and inversely proportional to rainfall. Sharma et al 2017 first observed *P. brassicae* in the 43rd standard week (1.33 larvae plant-1) and lowest population of 0.12 larvae per plant during the 15th standard week. The *P. brassicae* population was maximum (5.74 larvae plant-1) in 7th standard week, respectively. The maximum and minimum temperature showed significant negative correlation with r values, while relative humidity (morning) had a positive and highly significant effect with r value impact on larval population. Whereas relative humidity (evening) and rainfall had no significant effect with r value on the larval population.

**Table 5. Pooled Population dynamics of *P. brassicae* L in relation to agro climatic condition.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Population of the indicated stage** | | | | |
| **S.No** | **Standard**  **Week** | **No. of egg** | **No. of larva** | **No. of pupa** | **No. of adult** |
| **1** | **17& 37** | 3.49  (2.00) | 3.96  (2.11) | 1.99  (1.58) | 0.82  (1.15) |
| **2** | **18& 38** | 4.27  (2.18) | 4.67  (2.27) | 3.28  (1.94) | 0.83  (1.15) |
| **3** | **19& 39** | 6.30  (2.61) | 8.33  (2.97) | 4.73  (2.29) | 1.43  (1.39) |
| **4** | **20& 40** | 6.79  (2.70) | 9.65  (3.19) | 4.93  (2.33) | 1.01  (1.23) |
| **5** | **21& 41** | 7.13  (2.76) | 10.01  (3.24) | 4.54  (2.24) | 0.98  (1.22) |
| **6** | **22& 42** | 6.77  (2.70) | 10.14  (3.26) | 6.93  (2.73) | 1.26  (1.33) |
| **7** | **23&43** | 10.03  (3.24) | 10.70  (3.35) | 7.72  (2.87) | 1.20  (1.30) |
| **8** | **24& 44** | 10.99  (3.39) | 9.63  (3.18) | 9.49  (3.16) | 0.98  (1.22) |
| **9** | **25& 45** | 9.36  (3.14) | 8.57  (3.01) | 7.97  (2.91) | 0.92  (1.19) |
| **10** | **26& 46** | 7.23  (2.78) | 7.05  (2.75) | 5.88  (2.53) | 0.73  (1.11) |
| **11** | **27& 47** | 5.37  (2.42) | 4.65  (2.27) | 4.64  (2.27) | 0.66  (1.08) |
| **12** | **28& 48** | 3.15  (1.91) | 3.77  (2.07) | 3.21  (1.93) | 0.48  (0.99) |
| **SE (d)** |  | 0.05 | 0.07 | 0.04 | 0.03 |
| **C.D ( 0.05)** |  | 0.11 | 0.15 | 0.10 | 0.06 |

Figure in parentheses are square root transformation.

**Table 6: Relationship between *Pieris brassicae* Population and Weather parameters on Broccoli from 17th -37th to 28th to 48th standard weeks at Bharsar condition.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Correlation co-efficients (r)**  **Weather parameters** | **No of eggs** | **No of larvae** | **No of pupae** | **No of**  **Adult** |
| **Temperature (0C)** | 0.184 | 0.285 | 0.420 | 0.254 |
| **Rainfall (mm)** | -0.133 | -0.505 | -0.441 | -0.477 |
| **Sunshine hour** | 0.284 | 0.148 | 0.320 | 0.420 |

\*significant at 5% level of significance

**Figure 3.** Weather graph during 17th – 28th standard week and 37th– 48th standard week

**4. CONCLUSION**

During the first season (17th–28th standard week), the egg of the cabbage butterfly increased gradually and reached a peak level of 11.49 eggs at the 24th standard week, 12.83 larvae at the 23rd standard week, 10.49 pupae at the 24th standard week and 1.34 adults at the 23rd standard week. Thereafter, a declined trend was observed due to the fall of temperatures, fewer sunshine hours and rainfall as the optimum weather conditions for the cabbage butterfly were decreasing. In the second season (37th – 48th standard week), the eggs laid by the Cabbage white butterfly increased gradually and reached a peak level of 10.49 eggs at the 44th standard week, 10.56 larvae at the 40th standard week, 8.48 pupae at the 48th standard week and 0.48 adults at the 48th standard week. The declined trend was observed due to the fall of optimum weather conditions for the cabbage butterfly. Therefore, the average population of the cabbage butterfly (P. brassicae) during the 2 seasons was positively correlated with temperature and sunshine hours but negatively correlated with rainfall.

**5. DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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