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# Effect of Weather Parameters on Population Dynamics of Coccinellids in Sugarcane

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Study of the population dynamics of coccinellids were carried out from 28th to 12th SMW during 2022-23. Two species *Micraspis yasumatsui* and *Cheilomenes sexmaculata* were found active throughout the whole study period. The population of *Coccinellaseptempunctata, Propyleadissecta, Coccinella transversalis* first appeared from 30thSMW and reach their peak population during 2ndSMW, whereas the population of *Micraspis yasumatsui*and *Cheilomenes sexmaculata* started from 28th SMW and reach their peak during 52nd and 2ndSMW respectively. The coccinellids showed positive and highly significant correlation with relative humidity and negative and highly significance with maximum temperature.

*Keywords: Coccinellids; population; weather parameters; correlation coefficient; sugarcane.*

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## 1. INTRODUCTION

The Coccinellidae is a very well-known, diverse and abundant family of natural enemies. Around 400 coccinellid species have been reported from the Indian subcontinent [1]. Ladybirds thought to evolved during the lower Permian period, *i.e.,*about 280 million years [2],the first very successful study of classical biological control was the induction of ladybird beetle, *Rodalia cardinalis* which is native of Australia. It was introduced to California for the management of the cottony cushion scale, *Icerya purchasi*, in 1888 [3]. Sathe and Bhosale in 2001 described more than 4500 species of coccinellids, which were predacious in nature [4]. During the past few years, the attack of sucking pests has been increased in India on different agricultural and horticultural crops. Coccinellids are either phytophagous or mycophagous [5].About 90% of coccinellid species are predatory in nature this predatory coccinellids can be grouped into two categories aphidophagous (*Coccinella septempunctata, Chelominussexmaculata, Coccinella transversalis etc.*) and coccidophagous (*Scymnuscroccivora, phharoscymnushorni, etc.)*. However the species like *Cryptolaemus montrouzieri* feed on mealybugs besides these, They also feed on phytophagous insects of agricultural, horticultural and forestry species like aphids, whiteflies, mites, psyllids, plant hoppers, coccids, psuedococcids, thrips, eggs and larvae of other insects [6,7]. Both the grubs and adults have the same feeding habits; they are both involved in controlling the pest population. Homopterans are more suitable for biological control, because homopterans are less mobile and live in cracks and crevices where chemicals cannot reach. In such circumstances, bio-control agents can have a pivotal role to play. Temperature's impact is typically assessed by establishing a distinct relationship between temperature and its influence on survival, reproductive capacity, demographic factors, growth rate, and maturation, which is then used for predicting interaction among bio control agents and their host insects. Temperature driven models are often used to estimate the seasonal population dynamics of pests and natural enemies in field situations. The observed levels of adaptation, diversity, abundance, and effectiveness in limiting the population of pests vary depending on the species and environmental factors. Keeping in this viewpoint “studies on population dynamics of Coccinellids in relation to abiotic factors in sugarcane was undertaken with the aforementioned goals.

## 2. MATERIALS AND METHODS

The population dynamics of major dominated coccinellids beetles were studied at kalyanpur farm during 2022-23. Geographically is located at the longitude, latitude and an altitude of $85.79^0$E, $25.96^0$N and 176ft respectively. The field experiments were conducted with an area of 0.1 ha with variety Rajendra Ganna-1.The cultivation followed standard agronomic practices with the crop being grown at a distance of 90 cm between rows. No insecticides were used on the crop. Observations were collected through random sampling of 25 plants at fortnightly intervals, whereas the adults were counted.

### 2.1 Statistical Analysis

Weather information was gathered from the University's meteorological unit, to find correlation between the populations of major coccinellids and abiotic factors. The data was statistically analyzed using OP stat software. A regression analysis was conducted to determine how much impact weather factors had on the population fluctuations of coccinellids.

## 3. RESULTS AND DISCUSSION

The observations were taken on incidence of 5 coccinellid species such as *Coccinella septempunctata, Propylea dissecta, Micraspis yasumatsui, Coccinella transversalis* and *Cheilomenessexmaculata.* Number of adults per plant was recorded. The fortnightly observation on the occurrence of coccinellids beetles were started from $28^{th}$ standard week onward till $12^{th}$ standard week. The population increase in these coccinellids were greatly impacted by different abiotic factors such as temperature, relative humidity, rainfall and so on. Recorded values are presented in Tables 1 and 2.The values of correlation coefficient between weather parameters and coccinellid population is indicated in Table 3.

### 3.1 *Coccinella septempunctata*

The population of the *Coccinella septempunctata* was first appeared from $30^{th}$SMW as 0.04 adults per plant and the corresponding weather parameters such as maximum temperature of $33.75^0$C, minimum temperature of $25.45^0$C, morning relative humidity 90.50%, and evening relative humidity of 71.00%, rainfall of 162.70 mm was observed during that time period. The population increased slowly and reached its peak

population during 42$^{nd}$SMW and start decreasing gradually again it starts increasing its population gradually and reaches its peak population during 2$^{nd}$SMW (0.36 adults per plant). Simple correlation coefficient was found out with weather parameter (Table 3) showed negative and highly significant correlation was found with maximum temperature (r=-0.571$^{**}$). A positive and highly significant correlation was found with maximum relative humidity (0.635**). Negative and Non-significant correlation was found with the Minimum temperature (r=-0.431$^{NS}$) and rainfall (-0.276$^{NS}$), whereas positive and non-significant correlation was found with minimum relative humidity (r=0.128$^{NS}$). The coefficient value ($R^2$) was 0.72 percent which suggests that 72% of the fluctuation in the *Coccinella septempunctata* population can be attributed to the impact of abiotic factors.

### 3.2 *Propylea dissecta*

The population of *Propylea dissecta* started to exhibit its activity from 30$^{th}$SMW as 0.04 adults per plant and the corresponding weather parameters such as maximum temperature of 33.75$^0$C, minimum temperature of 25.45$^0$C, morning relative humidity 90.50%, and evening relative humidity of 71.00%, rainfall of 162.70 mm was observed during that time period. The population increased slowly and reached its peak population during 2$^{nd}$SMW (0.36 adults per plant) whereas maximum and minimum temperature were 15.46$^0$C and 8.00$^0$C respectively, the morning and evening relative humidity were 97.00% and 78.21% respectively and the rainfall recorded was 0.00 mm. Simple correlation coefficient was find out with weather parameter (Table 3) and a Negative and highly significant correlation was found with maximum temperature (r=-0.660$^{**}$) and minimum temperature (r=-0.558**). A positive and highly significant correlation was found with maximum relative humidity (r=0.652**). Negative and non -significant correlation was fond with minimum relative humidity (r= -0.035$^{NS}$) whereas positive and non -significant correlation was found with rainfall (r=0.399$^{NS}$). The coefficient value ($R^2$) was 0.68 percent which suggests that 68% of the fluctuation in the population of *Propyleadissecta* can be attributed to the impact of abiotic factors.

### 3.3 *Micraspis yasumatsui*

The population of *Micraspis yasumatsui* start appearing from 28$^{th}$ SMW as 1.04 adults per palnt, the corresponding weather parameters such as maximum temperature of 35.35$^0$C, minimum temperature of 26.40$^0$C, morning relative humidity 82.50%, and evening relative

**Table 1. Meteorological data during the experimental period from 2022-23**

| Date | Temperature (°C) | | Relative humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|
| | Max | Min | Morning | Evening | |
| 15/7/2022 | 35.35 | 26.40 | 82.50 | 64.00 | 0.60 |
| 29/7/2022 | 33.75 | 25.45 | 90.50 | 71.00 | 162.70 |
| 12/8/2022 | 33.40 | 25.10 | 92.00 | 73.00 | 103.10 |
| 26/8/2022 | 34.10 | 25.10 | 89.00 | 72.00 | 20.80 |
| 9/9/2022 | 32.70 | 24.85 | 95.50 | 78.50 | 131.20 |
| 23/9/2022 | 32.05 | 24.85 | 93.50 | 78.00 | 89.80 |
| 7/10/2022 | 33.00 | 24.30 | 94.50 | 73.50 | 44.40 |
| 21/10/2022 | 31.95 | 21.10 | 96.00 | 64.50 | 42.70 |
| 4/11/2022 | 31.70 | 16.65 | 95.00 | 52.00 | 0.00 |
| 18/11/2022 | 29.60 | 14.90 | 95.50 | 49.00 | 0.00 |
| 2/12/2022 | 28.05 | 12.15 | 97.00 | 47.50 | 0.00 |
| 16/12/2022 | 25.65 | 9.80 | 98.00 | 53.00 | 0.00 |
| 30/12/2022 | 22.15 | 9.90 | 99.50 | 66.00 | 2.30` |
| 13/1/2023 | 15.46 | 8.00 | 97.00 | 78.21 | 0.00 |
| 27/1/2023 | 22.20 | 8.82 | 99.07 | 65.28 | 0.00 |
| 10/2/2023 | 24.66 | 10.43 | 98.21 | 59.71 | 0.00 |
| 24/2/2023 | 27.91 | 9.66 | 96.50 | 45.78 | 0.00 |
| 10/3/2023 | 30.37 | 13.76 | 98.17 | 46.78 | 1.80 |
| 24/3/2023 | 29.79 | 16.60 | 94.57 | 56.78 | 18.00 |

**Table 2. Major coccinellids population on sugarcane in relation to weather factors from 2022-23**

| Month | Date of observation | SMW* | Mean no. of adults/plant | | | | |
|---|---|---|---|---|---|---|---|
| | | | ***Coccinella septempunctata*** | ***Propylea dissecta*** | ***Micraspis yasumatsui*** | ***Coccinella transversalis*** | ***Cheilomenes sexmaculatus*** |
| July | 15/07/2022 | 28 | 0.00 | 0.00 | 1.04 | 0.00 | 0.04 |
| | 29/07/2022 | 30 | 0.04 | 0.04 | 0.88 | 0.08 | 0.08 |
| August | 12/08/2022 | 32 | 0.04 | 0.08 | 0.80 | 0.12 | 0.08 |
| | 26/08/2022 | 34 | 0.08 | 0.16 | 0.92 | 0.08 | 0.12 |
| September | 09/09/2022 | 36 | 0.20 | 0.16 | 1.20 | 0.20 | 0.20 |
| | 23/09/2022 | 38 | 0.16 | 0.12 | 1.32 | 0.24 | 0.20 |
| October | 07/10/2022 | 40 | 0.32 | 0.24 | 1.40 | 0.36 | 0.32 |
| | 21/10/2022 | 42 | 0.36 | 0.32 | 1.72 | 0.40 | 0.36 |
| November | 04/11/2022 | 44 | 0.24 | 0.28 | 1.60 | 0.32 | 0.32 |
| | 18/11/2022 | 46 | 0.24 | 0.24 | 1.52 | 0.28 | 0.20 |
| December | 02/12/2022 | 48 | 0.16 | 0.16 | 1.44 | 0.20 | 0.16 |
| | 16/12/2022 | 50 | 0.20 | 0.24 | 1.20 | 0.24 | 0.20 |
| | 30/12/2022 | 52 | 0.40 | 0.44 | 1.92 | 0.36 | 0.32 |
| January | 13/01/2023 | 2 | 0.36 | 0.36 | 1.88 | 0.40 | 0.44 |
| | 27/01/2023 | 4 | 0.24 | 0.28 | 1.60 | 0.32 | 0.36 |
| February | 10/02/2023 | 6 | 0.20 | 0.20 | 1.40 | 0.20 | 0.28 |
| | 24/02/2023 | 8 | 0.12 | 0.16 | 1.20 | 0.20 | 0.24 |
| March | 10/03/2023 | 10 | 0.12 | 0.12 | 1.12 | 0.12 | 0.16 |
| | 24/03/2023 | 12 | 0.04 | 0.04 | 0.92 | 0.08 | 0.08 |

**SMW- Standard Meteorological Week*

**Table 3**. **Correlation coefficient (r) between major coccinellid species against weather parameters during experimental period 2022-23**

| Coccinellid species | Temperature (oC) | | Relative humidity (%) | | Rainfall (mm)($X_5$) | $R^2$value |
|---|---|---|---|---|---|---|
| | Maximum($X_1$) | Minumum($X_2$) | 07.00 hrs($X_3$) | 14.00 hrs($X_4$) | | |
| *Coccinellaseptempunctata* | -0.571** | -0.431NS | 0.635** | 0.128NS | -0.276NS | 0.7233 |
| *Propyleadissecta* | -0.660** | -0.558** | 0.652** | -0.035NS | 0.399NS | 0.6822 |
| *Micraspisyasumatsui* | -0.661** | -0.556** | 0.581** | -0.016NS | -0.440* | 0.6611 |
| *Coccinella transversalis* | -0.526* | -0.407NS | 0.632** | 0.105NS | -0.227NS | 0.6496 |
| *Cheilomenessexmaculatus* | -0.664** | -0.529* | 0.642** | 0.113NS | -0.337NS | 0.6868 |

***Level of significance = 1%(p=0.01) *Level of significance = 5% (p=0.05) NS = Non significant*

*Whereas, $X_1$ = Maximum temperature ($^0$C); $X_2$ = Minimum temperature ($^0$C); $X_3$ = Maximum R.H. (%); $X_4$ = Minimum R.H.(%); $X_5$= Rainfall (mm/day).*

humidity of 64.00%, rainfall of 0.60mm was observed during that time period. The population increased slowly and reached its peak population during 52$^{nd}$SMW (1.92 adults per plant) whereas maximum and minimum temperature were 22.15$^0$C and 9.90$^0$C respectively, the morning and evening relative humidity were 99.50% and 66.00% respectively and the rainfall recorded was 2.30mm. Simple correlation coefficient was find out with weather parameter (Table 3) shows that negative and highly significant correlation was found with maximum temperature (r=-0.661$^{**}$) and minimum temperature (r=-0.556**). A positive and highly significant correlation was found with maximum relative humidity (r=0.581**). Negative and non-significant correlation was found with minimum relative humidity (r= -0.016$^{NS}$) whereas positive and significant correlation was found with rainfall (r=0.440$^{*}$). The coefficient value ($R^2$) was 0.66 percent which suggests that 66% of the fluctuation in the population of *Micraspis yasumatsui* can be attributed to the impact of abiotic factors.

### 3.4 *Coccinella transversalis*

The population of *Coccinella transversalis* started to exhibit its activity from 30$^{th}$SMW as 0.08 adults per plant and the corresponding weather parameters such as maximum temperature of 33.75$^0$C, minimum temperature of 25.45$^0$C, morning relative humidity 90.50%, and evening relative humidity of 71.00%, rainfall of 162.70 mm was observed during that time period. The population increased slowly and reached its peak population during 2$^{nd}$SMW (0.4 adults per plant) whereas maximum and minimum temperature were 15.46$^0$C and 8.00$^0$C respectively, the morning and evening relative humidity were 97.00 % and 78.21% respectively and the rainfall recorded was 0.00 mm. Simple correlation coefficient was find out with weather parameter (Table 3) and a Negative and significant correlation was found with maximum temperature (r=-0.526$^{*}$). A positive and highly significant correlation was found with maximum relative humidity (r=0.632**). Negative and non-significant correlation was found with minimum temperature (r=-0.407$^{NS}$) and rainfall (r=-0.227$^{NS}$). Positive and non-significant correlation was found minimum relative humidity (r= 105$^{NS}$) whereas the coefficient value ($R^2$) was 0.64 percent which suggests that 64% of the fluctuation in the population of *Coccinella transversalis* can be attributed to the impact of abiotic factors. The findings of Sharma et al. in 1996 shows that the adults of *C. transversalis* were observed alongside aphids infestation in the 3$^{rd}$ week of September [8].

### 3.5 *Cheilomenes sexmaculata*

The population of *Cheilomenes sexmaculata* started appearing from 28$^{th}$ SMW as 0.04 adults per plant, the corresponding weather parameters such as maximum temperature of 35.35$^0$C, minimum temperature of 26.40$^0$C, morning relative humidity 82.50%, and evening relative humidity of 64.00%, rainfall of 0.60 mm was observed during that time period. The population increased slowly and reached its peak population during 2$^{nd}$SMW (0.44 adults per plant) whereas maximum and minimum temperature were 15.46$^0$C and 8.00$^0$C respectively, the morning and evening relative humidity were 97.00% and 78.21% respectively and the rainfall recorded was 0.00 mm. Simple correlation coefficient was find out with weather parameter (Table 3) shows that the positive ad highly significant correlation with maximum temperature (r= - 664$^{**}$) and positive and highly significant relation with morning relative humidity (r=0.642$^{**}$).Whereas the coefficient value ($R^2$) was 0.68 percent which suggests that 68% of the fluctuation in the population of *Cheilomenes sexmaculata* can be attributed to the impact of abiotic factors. Tank in 2006 documented that the larval and adult populations of *C. sexmaculata* on cowpea crops displayed an inverse correlation with factors like minimum temperature, relative humidity during the evening, rainfall, wind speed, and morning as well as evening vapour pressure [9].

The present is finding fully supported with Sundereswari et al.in 2019, reported that population dynamics of lady bird beetle showed negative correlation with minimum and maximum temperature. It means when temperature increase the ladybird population decrease [10]. Whereas as per Megha et al. in 2015 reported the coccinellids population had positive correlation relative humidity in sorghum, maize and sunflower [11].

## 4. CONCLUSION

Present study on population dynamics of different coccinellid beetles on sugarcane revealed the dynamics of these predators in relation to abiotic factors. Correlation study for *C. septempunctata*(r=-0.571**), *Propylea dissecta* (r= -0.660$^{**}$), *Micraspis yasumatsui* (r= -661$^{**}$), *C. sexmaculata* (r=-0.664**) and *C. transversalis*

(r=-0.526**) showed negative and significant correlation with maximum temperature which means that the population of these beetles decreases with the increasing temperature. Correlation study of *C. septempunctata*(r=0.635**), *Propylea dissecta* (r= 652**), *Micraspis yasumatsui* (r= 581**), *C. sexmaculata* (r=0.642**) and *C. transversalis* (r=632**) with maximum relative humidity exhibited positive and significant correlation which means that as the relative humidity increases the population of these beetles also increases. This knowledge could be helpful for their mass rearing and utilization in biological control programs.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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