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Seasonal Abundance and Population Dynamics of *Chrysoperla* spp. in Tomato Agroecosystems

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***Abstract*— *The study investigated the seasonal abundance and population dynamics of Chrysoperla spp. on tomato crops across two consecutive years, focusing on the influence of environmental factors and prey availability. Observations revealed distinct peaks in egg (4.2 eggs/plant in the 16th SMW, 2023; 1.6 eggs/plant in the 16th SMW, 2024) and larval densities (2.4 larvae/plant in the 16th SMW, 2023; 2.0 larvae/plant in the 15th SMW, 2024). Maximum and minimum temperatures positively correlated with egg (r=0.492*), larval (r=0.662**), and pupal (r=0.504*) stages, while high morning and evening relative humidity negatively impacted all developmental stages. Adult populations showed moderate peaks (0.6 adults/plant in 16th SMW, 2023; 19th SMW, 2024) but were also constrained by high humidity levels. Prey availability, particularly whitefly and jassid populations, exhibited a supplementary role in supporting larval development. Comparisons with previous studies revealed consistent trends, with optimal temperatures and low humidity favouring Chrysoperla populations, while excessive moisture inhibited their activity. The study emphasises the importance of temperature and prey abundance in regulating Chrysoperla population dynamics, underscoring its significant role as a biological control agent in tomato agroecosystems. Integrating Chrysoperla into Integrated Pest Management (IPM) strategies, alongside climate-optimized practices, can effectively enhance pest suppression and ensure sustainable crop protection.*

***Keywords*— Chrysoperla zastrowi sillemi, Tomato, Seasonal abundance, Environmental factors, Biological control, Pest management, Population dynamics.**

I. INTRODUCTION

Green lacewings, often called "golden eyes" and "aphid lions," are renowned biocontrol agents in the order Neuroptera. Their larvae are voracious predators, capable of consuming over 300 aphids in their lifetime, while adults primarily feed on nectar, honeydew, and pollen, enhancing their survival and fecundity (Legaspi *et al.*, 1994; Michaud, 2001; Villenave *et al.*, 2006). In India, *Chrysoperla zastrowi sillemi*, formerly known as *C. carnea*, is the most dominant and economically significant species, exhibiting a broad host range, insecticide resistance, and adaptability to diverse ecosystems (Henry *et al.*, 2010; Hemalatha *et al.*, 2014; Gonzalez *et al.*, 2015). Their ability to thrive across varied environmental conditions, combined with ease of mass-rearing and strong predatory efficiency against soft-bodied pests like aphids, jassids, and mites, makes them an essential component of sustainable Integrated Pest Management (IPM) strategies (Pappas *et al.*, 2011). Furthermore, their role in reducing chemical pesticide dependence highlights their ecological and economic importance in modern agriculture (Wäckers and van Rijn, 2012; Gonzalez *et al.*, 2015).

II. MATERIAL AND METHOD

Present study on seasonal abundance of *Chrysoperla* spp. was conducted at the Research Farm of the Department of Entomology, CCS HAU, Hisar, from 2022–2024. Hisar is located at 29.1492° N latitude and 75.7217° E longitude, with an elevation of 215 m above sea level. The region experiences extreme weather conditions, with summer temperatures reaching 40–46°C, winter temperatures dropping to 1.5–4°C, and rainfall primarily occurring during the Southwest monsoon and winter western disturbances. The area is also occasionally affected by strong winds and intermittent dust storms. The present study was conducted to assess the seasonal abundance and population dynamics of *Chrysoperla* spp. in tomato during the summer season. Tomato was selected as a representative crop to study the predator-prey interactions and the influence of environmental factors on *Chrysoperla* spp. abundance. The crop provided a suitable host environment and consistent prey availability, allowing a detailed analysis of population trends across different growth stages and seasonal conditions. For tomato, 30 representative plants were randomly selected for weekly observations throughout the study period. Monitoring was systematically conducted to record the different developmental stages of *Chrysoperla* spp.—eggs, larvae, pupae, and adults—along with their density and distribution on the selected plants. The population of major sucking pests, *i.e.* whitefly was also recorded to understand predator-prey interactions and their seasonal trends. Weekly data collection included critical weather parameters such as maximum and minimum temperatures, morning and evening relative humidity, rainfall, rainy days, and sunshine hours. These parameters were meticulously documented and analysed to identify their correlation with the seasonal abundance of *Chrysoperla spp.* in the tomato crop. Pearson's correlation coefficient was used to analyse the relationship between weather variables, prey populations, and different life stages of *Chrysoperla spp.* Statistical analysis was performed using a software package developed by CCS HAU, Hisar, ensuring precise and reliable interpretation of the data.

Pearson's correlation coefficient: $r = \frac{n(\sum xy)-(\sum x)(y)}{\sqrt{[n(\sum x^2)-(\sum x^2)][n(\sum y^2)-(\sum y^2)]}}$

III. RESULTS AND DISCUSSION

The seasonal abundance and population dynamics of *Chrysoperla* spp. on tomato crops revealed distinct trends influenced by environmental conditions and prey availability across two growing seasons. In 2023 (Table 1), eggs were first observed in the 13th SMW, peaking at 4.2 eggs per plant in the 16th SMW under favourable conditions of 38.1°C maximum temperature, 21.2°C minimum temperature, and 8.2 hours of bright sunshine. In 2024, eggs appeared earlier in the 12th SMW, with densities reaching their highest at 1.6 eggs per plant in the 16th SMW under slightly lower temperatures and reduced sunshine hours. Larval populations followed a similar trend, appearing in the 13th SMW in 2023 and the 12th SMW in 2024, with peak densities recorded in the 16th SMW (2.4 larvae per plant) and the 15th SMW (2.0 larvae per plant), respectively. Pupal densities were comparatively lower, peaking at 0.4 pupae per plant in the 16th and 17th SMWs in 2023 and slightly earlier in the 10th SMW in 2024 (0.6 pupae per plant). Adult populations were also influenced by weather parameters, showing peaks of 0.6 adults per plant in the 16th SMW (2023) and the 19th SMW (2024). These findings align with observations by Mari *et al.* (2013), who reported peak *Chrysoperla carnea* densities at 1.52 individuals per plant during mid-March under temperatures around 36°C and dry weather conditions, indicating the importance of warm temperatures and low humidity in supporting predator abundance.

Weather variables played a significant role in determining the population trends of *Chrysoperla* spp. across both years (Table 2). Eggs exhibited positive correlations with maximum temperature in 2023 (r = 0.492*) and minimum temperature in 2024 (r = 0.634**), while morning (r = -0.591*) and evening relative humidity (r = -0.675**) negatively affected their abundance. Larvae showed strong positive correlations with both maximum (r = 0.662** in 2023, r = 0.581* in 2024) and minimum temperatures (r = 0.717** in 2023, r = 0.794** in 2024), while high morning (r = -0.592* in 2023, r = -0.810** in 2024) and evening humidity (r = -0.487* in 2023, r = -0.808** in 2024) limited their activity and survival. Similar findings by Nair et al. (2020) demonstrated that larvae thrive best under moderate humidity and temperatures ranging between 28–35°C, reinforcing the strong dependence of larval activity on optimal environmental conditions.

Pupal densities in the present study remained low (Table 1), with peak densities of 0.4–0.6 pupae per plant. Positive correlations with maximum and minimum temperatures suggest that dry, warm conditions favor pupation, while high humidity negatively impacts pupal survival. This agrees with Sreedhar et al. (2019), who observed similar trends, emphasizing that pupal survival is highly sensitive to excessive humidity. Furthermore, Singh (2017) highlighted that pupal success largely depends on consistent temperature conditions without abrupt fluctuations, which aligns with the observed patterns in our study.

Adult densities showed positive correlations with maximum (r = 0.564**) and minimum (r = 0.676**) temperatures (Table 2), with morning humidity negatively impacting adult abundance. Similar findings were reported by Duelli (2001), who emphasized the importance of stable temperature regimes for adult *Chrysoperla* survival and oviposition activity. Additionally, Singh et al. (2017) noted that adult *Chrysoperla* populations thrive in environments with reduced humidity and consistent sunshine hours, aligning with the patterns observed in our study.

Prey availability (Table 2), particularly whitefly, played a secondary yet supportive role in influencing *Chrysoperla* populations. While larval and adult stages depend on prey for growth and reproduction, their population patterns appeared more closely tied to weather parameters than prey abundance alone. This observation resonates with findings from Nair et al. (2020), who highlighted the efficiency of *Chrysoperla* larvae in suppressing aphid and whitefly populations in tomato ecosystems. Our study similarly observed a moderate but significant correlation between prey density and larval abundance, reinforcing the role of prey as a supplementary factor influencing predator dynamics.

In summary, the synchronized peaks of *Chrysoperla* eggs, larvae, pupae, and adults with favourable environmental conditions emphasize their adaptability to fluctuating weather patterns. Eggs peaked in the 16th SMW, larvae displayed their highest densities in the 15th–16th SMWs, and adults peaked slightly later, indicating a natural progression of population stages. These findings align with earlier studies by Mari et al. (2013) and Nair et al. (2020) highlighting the importance of temperature, relative humidity, and prey availability in shaping *Chrysoperla* population dynamics. Such insights contribute to a deeper understanding of *Chrysoperla zastrowi sillemi* ecology and its integration into sustainable pest management programs, reinforcing its potential as a reliable predator in tomato agroecosystems.

Table 1: Seasonal abundance of different stages of Chrysoperla spp. on tomato under field conditions during 2023 and 2024

SMW	1st year (2023)				2nd year (2024)			
	Egg	Larvae	Pupa	Adult	Egg	Larvae	Pupa	Adult
12	0	0	0	0.2	0.4	0.6	0	0
13	0.2	0.4	0	0	0.2	1.2	0	0.4
14	0.4	0.6	0.2	0	0.8	0.6	0	0
15	0.6	1.2	0	0	1.2	2.0	0.2	0.2
16	4.2	2.4	0.4	0.6	1.6	0.2	0.2	0.2
17	0.4	1.2	0.4	0.2	0.2	1.4	0	0
18	0.2	0.8	0.2	0.2	1.4	1.0	0	0
19	0.2	0.2	0	0	0.2	1.4	0.6	0.6

SMW: Standard Meteorological Weeks

Table 2: Correlation of Chrysoperla spp. population with weather parameters and pest population on tomato under field conditions during year 2023 and 2024

Weather parameters	1st year (2023)				2nd year (2024)			
	Stages of *Chrysoperla* spp.							
	Eggs	Larvae	Pupae	Adults	Eggs	Larvae	Pupae	Adults
Max. Temp. (°C)	0.492*	0.662**	0.504*	0.434	0.175	0.581*	0.832**	0.564 **
Min. Temp. (°C)	0.478	0.717**	0.595*	0.541*	0.634**	0.794**	0.519*	0676**
R.H. Morning (%)	-0.357	-0.592*	-0.505*	-0.317	0.591*	0.810**	-0.642**	0.417*
R.H. Evening (%)	-0.247	-0.487*	-0.507*	-0.186	-0.675**	-0.808**	-0.553*	-0.457
Bright Sunshine Hours	0.301	0.416	0.445	0.123	-0.632**	-0.630**	-0.341	-0.368
Rainfall (mm)	0.003	-0.043	0.022	0.016	0.422	0.491*	0.298	0.311
Rainy Days	-0.162	-0.199	-0.145	-0.129	-0.213	-0.196	-0.137	-0.172
Whitefly	0.293	0.376	0.273	0.197	0.33	-0.137	-0.406	-0.179

*Significance at 5% ** Significance at 1%

IV. CONCLUSION

The study revealed that *Chrysoperla zastrowi sillemi* populations on tomato crops are significantly influenced by environmental factors, particularly temperature, relative humidity, and sunshine hours. Egg and larval densities peaked under warm, dry conditions, while high humidity negatively impacted survival and activity across all life stages. These findings highlight the importance of optimizing environmental conditions and prey availability to maximize the biocontrol potential of *Chrysoperla zastrowi sillemi* in tomato agroecosystems, reinforcing its role in sustainable Integrated Pest Management (IPM) strategies.

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