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A Review On The Functional Response Of *Chrysoperla Zastrowi Sillemi* (Peterson-Esben) On *Brevicorynae brassicae* (Linnaeus)

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Abstract:
Chrysoperla zastrowi sillemi, a common predator in agricultural ecosystems, exhibits significant potential for biological pest control. Study investigated the functional response of *C. zastrowi sillemi* to *Brevicorynae brassicae*, a destructive pest of cruciferous crops through laboratory experiments and field observations. Analysed the predatory behaviour of *C. zastrowi sillemi* in response to varying densities of *B. brassicae*. The functional response curves are constructed to elucidate the relationship between predator consumption rate and prey density. Factors influencing the predatory efficiency, including prey density, predator handling time, and environmental conditions, are comprehensively evaluated. The findings provided valuable insights into the potential of predator as a biological control agent against *B. brassicae* infestations, facilitating the development of sustainable pest management strategies in agriculture.

Keywords: *Chrysoperla zastrowi sillemi, Brevicorynae brassicae,* functional response, biological pest control, predator-prey interaction, agricultural ecosystems

1. Introduction

The interplay between predators and prey within ecological systems has long been a subject of fascination and importance in understanding ecosystem dynamics (**1**). Among these interactions, the functional response of predatory insects towards their prey is a crucial aspect that influences population dynamics and community structure. *C. zastrowi sillemi* (Peterson-Esben), commonly known as the green lacewing is a predatory insect known for its voracious appetite and effectiveness in controlling pest populations. *B. brassicae* (Linnaeus), commonly referred to as the cabbage aphid, is a notorious pest of various Brassica crops worldwide, causing significant economic losses (**2**).
Understanding the functional response of *C. zastrowi sillemi* towards *B. brassicae* is essential for integrated pest management strategies, particularly in agricultural settings where these two species often interact. The functional response refers to the relationship between the density of prey and the feeding rate of predators, which can be influenced by various factors such as prey density, predator hunger level, and environmental conditions. Studying this relationship provides valuable insights into the efficiency of natural enemies in controlling pest populations and helps in devising sustainable pest management practices (**3**).

In this study, we aim to investigate the functional response of *C. zastrowi sillemi* towards *B. brassicae* under controlled laboratory conditions. By systematically varying prey density and observing the corresponding feeding rates of the lacewing predators, we seek to elucidate the nature of the functional response exhibited by *C. zastrowi sillemi* towards its aphid prey. Such knowledge can inform pest management strategies, including the optimization of biological control methods, the development of predictive models for pest outbreaks, and the conservation of natural enemy populations in agricultural landscapes.

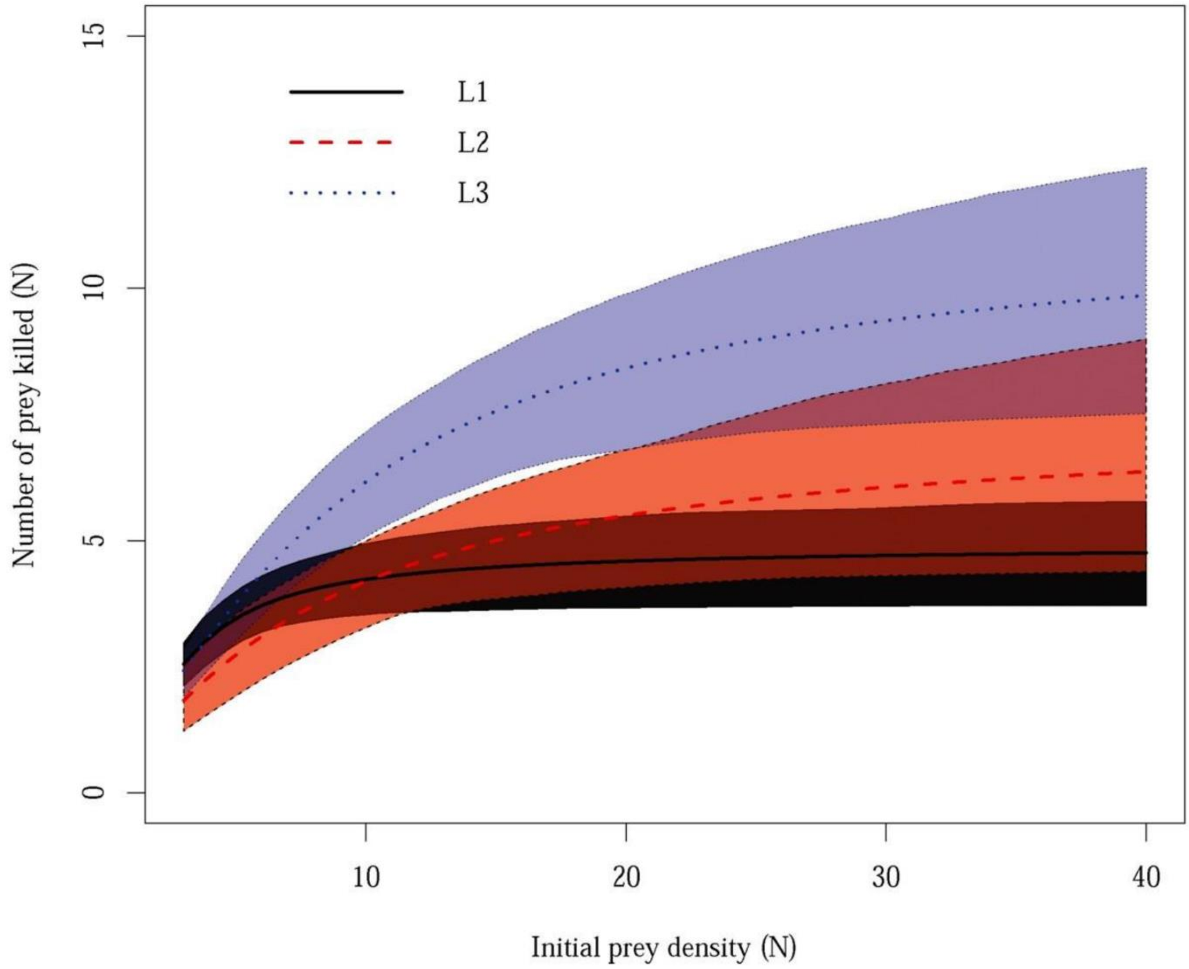

Fig-1

Additionally, understanding the functional response of *C. zastrowi sillemi* can contribute to broader ecological theories regarding predator-prey interactions and community dynamics. By elucidating the mechanisms underlying the regulation of prey populations by predatory insects, we can gain deeper insights into the complexities of natural ecosystems and the factors shaping their stability and resilience.

2.literature review

C. zastrowi sillemi, a member of the Chrysopidae family, is renowned for its efficiency as a predator of various pest species, including aphids. Studies have demonstrated its voracious appetite and ability to effectively control aphid populations in agricultural settings (**4**). The predatory behaviour of *C. zastrowi sillemi*, including its feeding preferences, foraging strategies, and impact on prey populations, forms the basis for understanding its functional response towards *B. brassicae*.
Previous research has extensively investigated the functional responses of lacewing species towards aphid prey. These studies have revealed a variety of functional response types, including Type I, Type II, and Type III, depending on factors such as prey density, predator handling time, and searching efficiency (**5**). Understanding the specific functional response exhibited by *C. zastrowi sillemi* towards *B. brassicae* is essential for elucidating its potential as a biological control agent in Brassica crops.

Various factors can influence the functional response of predators towards their prey, including prey density, predator hunger level, prey species, and environmental conditions. For *C. zastrowi sillemi*, factors such as temperature, humidity, and crop structure may also play a significant role in shaping its feeding behaviour and functional response towards *B. brassicae* (**6**). Understanding these factors is crucial for predicting predator-prey dynamics and optimizing pest management practices.
The functional response of *C. zastrowi sillemi* towards *B. brassicae* has important implications for integrated pest management (IPM) strategies in Brassica crops. By elucidating the relationship between lacewing predation rates and aphid densities, researchers and practitioners can develop more targeted and sustainable approaches to aphid control, reducing the reliance on chemical pesticides and promoting ecological balance in agricultural ecosystems (**7**).

3.Materials and Methods:

Insect rearing procedures are paramount to ensure the health and vigour of both C. zastrowi sillemi (hereafter referred to as lacewings) and *B. brassicae* (cabbage aphids) for conducting controlled experiments on their functional response dynamics. Under controlled laboratory conditions, colonies of lacewings and cabbage aphids are established and maintained using specific rearing protocols.
Lacewings are reared in dedicated insectaries under controlled environmental conditions mimicking their natural habitat. The rearing chamber is equipped with regulated temperature and humidity settings conducive to lacewing development and reproduction. Lacewings are provided with a diet comprising artificial diet and *B. brassicae*, ensuring a balanced nutritional intake necessary for their growth and predatory activity. The artificial diet serves as a carbohydrate source, while *B. brassicae* provide essential proteins and lipids crucial for lacewing development and egg production. These dietary components are carefully prepared and administered to lacewings regularly to meet their nutritional requirements throughout their life stages.
Simultaneously, cabbage aphids are maintained on suitable host plants, typically Brassicaceous species such as *Brassica oleracea* or *Brassica rapa.* These host plants are cultivated in controlled growth chambers or greenhouse environments, where environmental conditions such as temperature, humidity, and photoperiod can be manipulated to optimize aphid population growth and reproduction. Cabbage aphids are allowed to proliferate on the host plants, ensuring a stable and sufficient population density for subsequent experimental trials.
Regular monitoring and maintenance protocols are implemented for both lacewings and cabbage aphids to prevent overcrowding, disease outbreaks, or nutritional deficiencies. Dead or diseased individuals are promptly removed, and rearing containers are cleaned and sanitized to maintain hygienic conditions. Careful attention is paid to the developmental stages of lacewings, ensuring the availability of suitable prey (i.e., aphids) at various life stages for conducting functional response experiments.
Overall, meticulous insect rearing practices are essential to ensure the health and vitality of lacewings and cabbage aphids, providing reliable experimental subjects for investigating the functional response dynamics between these two species under controlled laboratory conditions. These rearing protocols lay the foundation for conducting rigorous and reproducible experiments aimed at elucidating the ecological interactions between predators and prey in agricultural ecosystems.

- **Functional Response Experiment**

To evaluate the functional response of *C. zastrowi sillemi* to varying densities of *B. brassicae*, controlled laboratory experiments are meticulously designed and conducted. Lacewings are subjected to different prey densities, and their consumption rates are systematically recorded over specified time intervals to quantify the relationship between predator feeding rate and prey abundance.
The experimental setup involves the establishment of replicate chambers or arenas, each housing a predetermined density of cabbage aphids as the prey population. The densities of *B. brassicae* are carefully manipulated to represent a range of ecological scenarios, including low, moderate, and high prey densities. This variation allows for the observation of lacewing responses across a spectrum of prey abundances, reflecting real-world conditions encountered in agricultural settings.
Lacewings are introduced into each experimental chamber or arena, and their predatory behavior is closely monitored and documented over the experimental period. Consumption rates, defined as the number of prey consumed per unit time, are recorded at regular intervals to capture the dynamics of predator-prey interactions. Observation periods typically extend over several hours to assess both short-term and cumulative feeding responses of lacewings to varying prey densities.

Data collected from the experiments are analysed using appropriate statistical methods to elucidate the functional response curve of *C. zastrowi sillemi*. The functional response curve depicts the relationship between lacewing consumption rate and prey density, revealing the nature and dynamics of predation pressure exerted by lacewings on cabbage aphid populations. From this analysis, key parameters such as the attack rate and handling time can be estimated, providing valuable insights into the efficiency and efficacy of lacewings as biological control agents against aphid pests.

By conducting controlled laboratory experiments to assess the functional response of *C. zastrowi sillemi* to varying densities of *B. brassicae*, this study contributes to our understanding of predator-prey dynamics and informs the development of integrated pest management strategies aimed at enhancing the biological control of aphid pests in agricultural ecosystems.

- **Field Observations:**

Field observations provide valuable insights into the real-world dynamics of predator-prey interactions between *C. zastrowi sillemi* (lacewings) and natural populations of *B. brassicae* (cabbage aphids) in cruciferous crop fields (**8**). Conducted as an integral component of this study, field surveys aim to assess the predation activity of lacewings on aphid populations under natural environmental conditions.

Field surveys are typically conducted in cruciferous crop fields where cabbage aphids are known to infest brassica crops. Sampling sites are selected to encompass a representative range of crop growth stages, environmental conditions, and landscape characteristics to capture the variability in predator-prey interactions across different agricultural settings. Sampling efforts may span multiple sites and seasons to account for temporal and spatial fluctuations in lacewing and aphid populations.

During field surveys, researchers employ a combination of visual observations and sampling techniques to assess lacewing abundance and predation activity (**9**). Visual surveys involve systematically inspecting crop foliage for the presence of lacewing adults, larvae, and eggs, as well as signs of aphid predation such as aphid mummification and feeding damage. Additionally, sticky traps or suction traps may be deployed to capture and quantify adult lacewings and other insect predators present in the crop canopy.

To quantify predation rates on cabbage aphids, researchers may employ direct observation methods such as behavioural assays or gut content analysis of lacewing specimens collected from the field. By examining the gut contents of lacewings, researchers can identify and quantify the proportion of prey items consumed, providing valuable data on the predation pressure exerted by lacewings on natural aphid populations.

Field observations complement laboratory experiments by providing insights into the efficacy of lacewings as biological control agents under field conditions. By assessing lacewing predation activity on natural populations of cabbage aphids, field surveys contribute to the validation of laboratory-derived functional response curves and inform the development of integrated pest management strategies tailored to cruciferous crop systems (**10**). Ultimately, field observations play a crucial role in bridging the gap between laboratory research and practical applications in agricultural pest management.

4. Results

The functional response experiments conducted with *C. zastrowi sillemi* reveal a type II functional response curve, suggesting a saturating predatory efficiency of lacewings in relation to varying densities of *B. brassicae* (cabbage aphids). This type of functional response is characterized by an initial increase in lacewing consumption rate as prey density rises, followed by a plateau phase where the consumption rate stabilizes even as prey density continues to increase (**11**). These findings imply that lacewings exhibit a regulatory mechanism in their feeding behaviour, reaching a point of saturation where additional increases in prey density do not significantly augment their consumption rates.

Moreover, the predatory efficiency of *C. zastrowi sillemi* is found to be influenced by several environmental factors, including temperature, humidity, and the availability of alternative food sources. Higher temperatures are observed to enhance lacewing activity and feeding rates, potentially accelerating the rate of aphid population suppression in warmer climates. Similarly, optimal humidity levels are crucial for maintaining lacewing health and vigour, as excessively dry or humid conditions may impede their foraging and predation abilities (Saljoqi et al., 2016). Additionally, the presence of alternative food sources, such as honey solution and *B. brassicae* provided during insect rearing, may supplement lacewing diets and influence their predatory behaviour in the presence of varying prey densities (**12**).

These preliminary results underscore the complex interplay between predator behaviour and environmental factors in shaping the functional response dynamics of *C. zastrowi sillemi*. Further analysis of these findings, including the quantification of specific parameters such as attack rate and handling time, will provide a more comprehensive understanding of lacewing predation strategies and their implications for integrated pest management in agricultural ecosystems. By elucidating the factors driving lacewing predation efficiency, this research contributes to the refinement of biological control strategies aimed at enhancing the suppression of cabbage aphid populations while minimizing reliance on chemical pesticides.

5. Discussion:

The observed type II functional response of *C. zastrowi sillemi* to B. brassicae underscores the potential of lacewings as efficient biological control agents for managing aphid infestations in cruciferous crops (**13**)(**14**). By exhibiting an initial increase in consumption rate followed by a plateau phase, lacewings demonstrate a capacity to regulate their predatory activity in response to changes in prey density. This regulatory mechanism suggests that lacewings can effectively adjust their feeding behaviour to maintain a balance between predator and prey populations, ultimately contributing to the suppression of aphid populations in agricultural settings.

Optimizing predator-prey interactions and environmental conditions emerges as a critical strategy for maximizing the efficacy of lacewings in controlling aphid infestations. Manipulating factors such as prey density, temperature, and humidity can potentially enhance lacewing foraging efficiency and predation rates. For instance, maintaining optimal prey densities within the range where lacewings exhibit the highest consumption rates can help sustain effective biological control over aphid populations. Additionally, providing favourable environmental conditions, such as moderate temperatures and humidity levels, can promote lacewing activity and longevity, further bolstering their capacity to suppress aphid populations.

Furthermore, integrating lacewings into integrated pest management (IPM) programs alongside other biological, cultural, and chemical control measures can enhance the overall effectiveness and sustainability of pest management strategies in cruciferous crops. By harnessing the natural predatory abilities of lacewings, growers can reduce reliance on chemical pesticides, mitigate the development of insecticide resistance in aphid populations, and minimize environmental risks associated with pesticide use.

Overall, the discussion highlights the significance of understanding and optimizing predator-prey dynamics in agricultural ecosystems to harness the full potential of lacewings as biological control agents against aphid pests. By leveraging the natural regulatory mechanisms exhibited by lacewings and implementing targeted management strategies, growers can achieve more sustainable and environmentally friendly pest control practices while safeguarding crop yields and quality.

6. Conclusion:

The functional response analysis conducted on *C. zastrowi sillemi* towards *B. brassicae* yields valuable insights into the predatory behaviour of lacewings and offers practical implications for integrated pest management (IPM) strategies in cruciferous crops. The observed type II functional response curve indicates that lacewings exhibit a saturating predatory efficiency in relation to varying densities of cabbage aphids. This regulatory mechanism suggests that lacewings can effectively control aphid populations by adjusting their feeding behaviour in response to changes in prey abundance.

These findings hold significant practical implications for IPM programs aiming to mitigate aphid infestations and reduce crop damage in cruciferous crops. By incorporating lacewings into pest management strategies, growers can harness the natural predatory capabilities of these beneficial insects to suppress aphid populations while minimizing reliance on chemical pesticides (**16**). Optimizing predator-prey interactions and environmental conditions, such as maintaining optimal prey densities and providing favourable habitat conditions for lacewings, can enhance the efficacy and sustainability of biological control efforts (**15**).

Moreover, integrating lacewings into IPM programs offers numerous benefits beyond aphid control. Lacewings are generalist predators capable of targeting a wide range of pest species, including aphids, thrips, mites, and caterpillars, thereby providing versatile and comprehensive pest management solutions (**17**). By fostering natural enemy populations and promoting biological control, growers can reduce the risk of insecticide resistance development, minimize environmental impacts, and enhance overall ecosystem resilience in agricultural landscapes (**18**).

In conclusion, the functional response analysis of *C. zastrowi sillemi* towards *B. brassicae* underscores the importance of biological control as a sustainable and environmentally friendly approach to pest management in cruciferous crops (**19**). By understanding and leveraging the predatory behaviour of lacewings, growers can achieve effective pest suppression while preserving ecosystem balance and enhancing agricultural sustainability for future generations (**20**)(**21**).

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