LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

ASSESSMENT OF BIOLOGICAL CONTROL AGENTS FOR MANAGING WHEAT APHIDS IN FIELD AND LABORATORY CONDITIONS

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Abstract:

This study evaluates the average consumption rates of biological control agents of wheat aphids in wheat crops during the Spring of 2021-2022. Two experiments were conducted *i.e* one under field conditions and another under laboratory conditions. In the field experiment, *Chrysopa* Mature Larva exhibited the highest average consumption rate, followed by Ladybird Beetle (LBB) Mature Larva. In the laboratory experiment*, Chrysoperla carnea (C. carnea*) adult stages showed relatively higher consumption rates compared to LBB adult stages. Combining *C. carnea* adult stages with LBB adult stages resulted in the highest average consumption rate among all treatments. These findings provide valuable insights into the effectiveness of different predator species and stages in controlling wheat aphid populations, informing the development of integrated pest management strategies for sustainable agriculture.

Keywords: *Bio control, wheat aphids, predators, integrated pest management, consumption rates.*

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is a major crop which plays a significant role in economic stability of Pakistan (Anwar *et al.,* 2009). Although many insect pests attack wheat plantations in Pakistan, the highest damage is caused by aphids. Aphids cause yield losses either directly (35 to 40%) by sucking the sap of the plants or indirectly (20 to 80%) by transmitting viral and fungal diseases (Aslam *et al.,* 2005). The aphid infestations significant affect wheat cultivars (Ahmad and Nasir, 2001) and other abiotic factors (Aheer *et al.,* 2007, 2008; Wains *et al.,* 2008). However, for integrated pest management, evaluation of more wheat cultivars would lead to selection of the most tolerant cultivar for aphid infestations under various situations.

Aphids can be managed in several ways like, cultural, physical, mechanical, biological, chemical and host plant resistance controls. Biological control is the major component of any integrated pest management strategy (Schöller *et al.,* 1997). Hover fly grubs, ground beetle, Coccinellid beetle, *Chrysoperla*, Syrphid fly sp. And earwigs are important natural enemies of aphid. Coccinellid beetles are important predators of aphids in agricultural crops and have been used as biological control agents against several pest aphids due to their ability to feed on a wide range of prey, to be very voracious, and to have a rapid numeric response (Hodek and Honěk, 1996). Use of selective insecticides which have the least harmful effect on parasite and predator could be the best option (Gair *et al.,* 1987). However, most of the synthetic insecticides seriously affect the populations of target and other non-target organisms. It is, therefore, advisable to use wheat cultivars which are resistant to the attack of aphids. The resistance of crop is an index of the balance that exists between the preference of the pest for a crop and its antibiosis against it. Nature also keeps check on these insect pests in the form of biological agents and environmental factors. In the present study, we investigated the effectiveness coccinellid and *Chrysoperla* predators towards the tested against wheat aphid infestations.

Materials and Methods

Experimental Setup:

The experiments were conducted to assess the average consumption rate of biological control agents targeting wheat aphids in wheat crops. Two separate experiments were conducted: one focusing on the consumption rates of predators of wheat aphids, and the other investigating the

consumption rates of different stages of predators under laboratory conditions during the spring season.

Experimental Subjects:

For both experiments, the following biological control agents were used:

1. *Chrysoperla carnea (Chrysopa):* Both adult and last instar grub stages.
2. Ladybird beetle (LBB): Both adult and mature larva stages.

1. Experimental Conditions:

1. Field Experiment

The field experiment was conducted during the wheat crop season of 2021-2022. The trials were carried out in wheat fields where aphid infestations were observed. Each treatment group consisted of a specific biological control agent. Observations were made daily for five consecutive days to record the consumption rates of wheat aphids by the predators. The experiment was replicated to ensure the reliability of the data.

2. Laboratory Experiment:

The laboratory experiment was conducted during the spring season of 2021-2022. Controlled laboratory conditions were maintained, including temperature, humidity, and light exposure. Individual predators or combinations of predators were introduced into controlled environments with wheat aphid populations. Daily observations were made over a five-day period to record the consumption rates of wheat aphids by the predators. Each treatment group was replicated to ensure consistency of results.

Data Collection:

1. In both experiments, the consumption rates of wheat aphids by the predators were recorded daily for five consecutive days.
2. Mean consumption rates were calculated for each treatment group across the five-day period.
3. Standard statistical analyses, including LSD tests at a 5% alpha level, were performed to compare the mean consumption rates between different treatment groups and days.

Data Analysis:

1. Statistical analysis was performed using appropriate software to analyze the mean consumption rates of wheat aphids by the different biological control agents.
2. LSD tests were conducted to determine significant differences between treatment groups and days.

Results

Field Experiment:

The average consumption rates of biological control agents of wheat aphids in wheat crops under field conditions during the spring of 2021-2022 are presented in Table 1.

Chrysopa Adult: The mean consumption rate ranged from 7.667 to 10.000 units over the five-day period, with an average consumption rate of 9.46 units.

Chrysopa Mature Larva: Consumption rates ranged from 35.667 to 46.000 units, with an average consumption rate of 39.06 units.

Ladybird Beetle (LBB) Adult: Consumption rates varied from 19.333 to 26.667 units, with an average consumption rate of 21.86 units.

LBB Mature Larva: Consumption rates ranged from 26.667 to 35.667 units, with an average consumption rate of 29.66 units.

Laboratory Experiment:

The average consumption rates of different stages of predators of wheat aphids under laboratory conditions during the spring of 2021-2022 are presented in Table 2.

***Chrysoperla carnea (C. carnea)* Adult**: Mean consumption rates ranged from 22.33 to 28.66 units, with an average consumption rate of 25.93 units.

***C. carnea* Last instar grub:** Consumption rates varied from 31.66 to 35.33 units, with an average consumption rate of 33.26 units.

Ladybird Beetle (LBB) Adult: Consumption rates ranged from 13.00 to 21.33 units, with an average consumption rate of 18.06 units.

Last instar grub of LBB: Consumption rates ranged from 12.33 to 19.33 units, with an average consumption rate of 15.59 units.

C. carnea + LBB (Adult stages): Consumption rates varied from 48.00 to 49.66 units, with an average consumption rate of 49.53 units.

Table 1: Average consumption rate of biological control agents of wheat aphids in wheat field crop (2021-2022).

Treatments	Mean consumption rate of Predators of wheat Aphids					
	Dat 1st	Day 2nd	Day 3rd	Day 4th	Day 5th	Average
Chrysopa Adult	9.667 c	10.000 d	7.667 c	10.000 d	10.000 d	9.46
Chrysopa Mature Larva	46.000 a	42.333 a	35.667 a	35.667 a	35.667 a	39.06
LBB Adult	24.667 b	19.667 c	26.333 b	19.333 c	19.333 c	21.86
LBB Mature Larva	26.667 b	27.333 b	35.667 a	29.333 b	29.333 b	29.66
LSD at 5% Alpha level	6.7506	4.8139	7.5639	5.4206	5.3381	-

Significant differences in mean consumption rates were observed among the treatment groups, as indicated by the LSD test at a 5% alpha level.

Table 2: Average consumption of different stages of predators of Wheat Aphids under laboratory condition during spring, 2021-2022.

Treatment	Mean consumption rate of Predators of wheat Aphids					Mean
	Day 1st	Day 2nd	Day 3rd	Day 4th	Day 5th	
C. carnea adult	28.66 b	28.00 b	28.00 c	22.66 c	22.33 c	25.93
C. carnea Last instar grub	35.33 b	32.33 b	35.33 b	31.66 b	31.66 b	33.26
LBB adult	18.66 c	21.33 c	19.00 d	18.33 c	13.00 d	18.06
Last instar grub of LBB	14.33 c	12.33 d	13.33 d	19.33 c	18.66 c	15.59
C. carnea + *LBB* (Adult stages)	49.66 a	48.33 a	52.33 a	49.33 a	48.00 a	49.53
LSD at 5% alpha level	8.2035	5.5381	5.7530	5.3763	4.8133	-

Significant differences in mean consumption rates were observed among the treatment groups, as indicated by the LSD test at a 5% alpha level.

Discussion:

The findings of this study provide valuable insights into the efficacy of biological control agents for managing wheat aphid populations in wheat crops. The observed differences in consumption

rates among predator species and stages highlight the importance of considering various factors when implementing biological control strategies in agricultural settings.

The higher consumption rates exhibited by larval stages of *Chrysopa* and Ladybird Beetle (LBB) compared to their adult counterparts are consistent with previous research indicating the greater voracity and feeding activity of immature stages in many insect predator species (Banks, 2018). Larval stages often have higher metabolic rates and greater energy demands, driving increased feeding rates and resulting in more efficient pest control (Hodek *et al.,* 2012).

Furthermore, the synergistic effects observed when combining predator species, such as *Chrysoperla carnea (C. carnea)* adults with LBB adults, suggest that integrated approaches combining multiple biological control agents may enhance aphid suppression beyond the capabilities of individual predators alone (Heimpel & Mills, 2017). This finding underscores the potential benefits of diversifying predator communities within agricultural ecosystems to improve pest management outcomes (Symondson *et al.,* 2002).

However, it is important to note that the efficacy of biological control agents can be influenced by various factors, including environmental conditions, prey availability, and pesticide use (Snyder & Ives, 2001). Future research should aim to elucidate the mechanisms underlying predator-prey interactions and optimize the deployment of biological control agents within integrated pest management (IPM) frameworks tailored to specific agroecosystems.

In conclusion, this study contributes to our understanding of the effectiveness of biological control agents for managing wheat aphid populations in wheat crops. By prioritizing the use of larval stages and exploring combinations of predator species, agricultural practitioners can develop more sustainable and environmentally friendly pest management strategies that reduce reliance on chemical pesticides and promote ecological resilience.

Conclusion

The study underscores the efficacy of larval stages of *Chrysopa* and Ladybird Beetle (LBB) in controlling wheat aphids, particularly in field conditions. Combinations of predator species, like *C. carnea* adult stages with LBB adult stages, show promise for effective aphid management.

Recommendations

1. Prioritize the use of larval stages of *Chrysopa* and LBB in pest management strategies.

2. Explore synergistic combinations of predator species for enhanced aphid suppression.

3. Conduct further research on predator-prey interactions and environmental factors.

4. Advocate for the adoption of integrated pest management (IPM) practices that integrate biological control methods for sustainable wheat production.

Authors contributions: All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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