**CORRELATIONSHIP BETWEEN APHIDS AND THEIR NATURAL ENEMEIES IN WHEAT AGROECOSYSTEM IN NORTH- WESTERN RAJASTHAN, INDIA**

**ABSTRACT**

Insect pests are a serious constraint on global wheat production. Pests can significantly impair agricultural output and quality. Among the several biotic and abiotic elements, insect pest damage results in a significant reduction in yield. Aphids are a severe wheat pest that can cause significant crop damage. Aphids can cause wheat damage through direct feeding, viral vectoring, and honeydew emission, which can result in fungal infections. The study analyzed the correlation between insect pests, specifically corn and wheat aphids, and their natural enemies in wheat during the *Rabi* seasons of 2023-24 and 2024-25. The experiment was conducted at the Instructional Experimental Farm, Agricultural Research Station, India. The population dynamics of major insect pests of wheat and their natural enemies was recorded at weekly interval right from appearance to till maturity of crop. The data recorded on the population of major insect pests and natural enemies were used for statistical analysis. The correlation was computed among the population of major insect pests, natural enemies using the standard formula. The syrphid fly showed strong positive relationships with both species, indicating their effectiveness as biological control agents. The ladybird beetles revealed a stronger positive correlation with wheat aphids, suggesting they may prefer them. Green Lacewing larvae also showed positive correlations with both species, with Wheat aphids showing higher values. The findings highlight the importance of conserving and enhancing populations of Syrphid Flies, Lady Bird Beetles, and Green Lacewings in wheat cusltivation to promote sustainable pest management strategies. Further research could explore how abiotic factors such as temperature, humidity, and rainfall modulate these relationships to optimize integrated pest management (IPM) approaches.

***Keywords*:** Correlation, syrphid fly, green lacewing, lady bird beetles, corn aphids and wheat aphids

**1. INTRODUCTION**

Intensive agriculture seriously threatens farmland biodiversity via pesticide use, growing a few crop species in monocultures and the often-concomitant reduction of semi-natural habitats. Ecological intensification has been coined as a more sustainable agricultural model, which is based on strengthening the provision of ecosystem services, such as pest suppression mediated by natural enemies (González et al., 2022). Wheat (*Triticum aestivum* L.) is a major grain crop in India, ranking second only to rice as a staple meal. It belongs to the Gramineae (or Poaceae) family, is predominantly composed of carbohydrates (78%), followed by protein (14%), fiber (12%), and fat (2%) (1). It is commonly consumed in processed forms such as bread, biscuits, cookies, noodles, porridge, pudding, pasta and vermicelli. India primarily cultivates three wheat species: *Triticum aestivum* (common wheat or bread wheat), *Triticum durum* (macroni or durum wheat), and *Triticum dicoccum* (emmer wheat) (2).

India is the second-largest wheat producer after China and produced 1132.92 lakh tonnes during 2023-24. Uttar Pradesh produced the most wheat (35.50 million tonnes), followed by Madhya Pradesh (17.62 million tonnes), Punjab (17.14 million tonnes), Haryana (12.36 million tonnes), Rajasthan (11.04 million tonnes), and Bihar (6.34 million tonnes) during 2023-24. In India, wheat output totalled 109.52 million tonnes with a yield of 3.464 tonnes per hectare (3). The area under the wheat crop in Rajasthan is about 29.54 lac. ha with the production of 113.57 lac tones and productivity of 3831 kg per ha (4). In Rajasthan, wheat is mainly grown in the districts of Sri Ganganagar, Hanumangarh, Alwar, Bharatpur, Bhilwara, Bundi, Chittorgarh, Kota, Jaipur, Bikaner, Nagaur, and Pali.

Insect pests are a serious constraint on global wheat production. Pests can significantly impair agricultural output and quality. The major insect pests attacking wheat crop reported in various parts of India are aphids (Hemiptera: Aphididae), termites (Isoptera: Termitidae), cutworms and armyworms (Lepidoptera: Noctuidae), thrips (Thysanoptera: Thripidae), chinch bugs (Hemiptera: Lygaeidae), leafhoppers (Hemiptera: Cicadellidae) stem borer, gujhia weevil (Coleoptera: Curculionidae) (5). Chemical control remains one of the most direct and effective methods. However, long-term application of large amounts of insecticides can lead to ecological problems such as pesticide residues, resistance, environmental pollution and deterioration of wheat yield environment, of particular concern is the harm caused to natural enemies of aphids, disrupting the balance of the ecosystem (Sharma et al., 2019; Singh et al., 2022).

Among the several biotic and abiotic elements, insect pest damage results in a significant reduction in yield. The yield loss for wheat has been estimated to be between 60 and 70 percent. In India, the attack of insect pests has resulted in an average yield loss of 8.7 percent globally, depending on the insect pest, different pest management techniques, crop varieties cultivated and agronomic practices used. Aphids are a severe wheat pest that can cause significant crop damage. Aphids can cause wheat damage through direct feeding, viral vectoring, and honeydew emission, which can result in fungal infections. Research indicates that aphid damage to wheat varies according to the species and stage of growth (6).

Wheat aphid population dynamics depend on temperature, humidity, and host plant availability. Aphid populations can decline at hot temperatures and low humidity, but flourish in moderate temperatures and high humidity. Aphid populations can be strongly impacted by the location and number of natural enemies, including predators and parasitoids. Aphid populations can be reduced by natural enemies that consume or lay eggs on them, resulting in their mortality (7).

**2. MATERIALS AND METHODS**

The experiment was conducted at the Instructional Experimental Farm, Agricultural Research Station, Sri Ganganagar, which is situated at 280 40 ’N latitude and 720 2’E longitude and at an altitude of 168 to 227 metres above the mean sea level. The region falls under Agro-climatic zone I-b *i.e.*  Irrigated North Western Plain Zone of the Rajasthan. The city of Sri Ganganagar is characterised by a desert climate. The precipitation is virtually absent during the year. The climate here is classified as BWh by the Köppen-Geiger. The temperature in this location is approximately 25.3 °C, as determined by statistical analysis. The annual rainfall is 367 mm. The sowing of wheat variety Raj 4238 was done in the area 4.5 x 3 m2 on first fort night of November of 2023 and 2024, keeping row to row distance of 22.5 cm. All agronomic practices were followed as per the recommendation of the package of Zone I-B.

The population dynamics of major insect pests of wheat and their natural enemies was recorded at weekly interval right from appearance to till maturity of the crop.

The Sucking pests were recorded at a weekly interval right from appearance to till maturity of the crop. For recording observations, 10 plants were selected randomly and tagged from the whole experimental plot. The population of sucking pests were recorded in early morning hours when the insects were inactive (before 8 AM) from five tillers of each randomly selected and tagged plant by using a magnifying lens.

Natural enemies: the total number of natural enemies was counted on randomly selected and tagged whole plants.

The data recorded on the population of major insect pests and natural enemies were used for statistical analysis. The correlation was computed among the population of major insect pests, natural enemies using the following formula:



Where,

rxy = Simple correlation coefficient

X = Variable *i.e.* abiotic factors*,* natural enemies

Y = Variable *i.e.* mean number of insect pests per plant

n = Number of observations.

**3. RESULTS AND DISCUSSION**

The population of syrphid fly showed significant negative correlation with maximum temperature (-0.824\*) and minimum temperature (-0.854\*), while positive correlations with morning relative humidity (0.734\*) and evening relative humidity (0.584\*). The rainfall effect was non-significant (0.144). The lady bird beetles population showed significant negative correlation with maximum temperature (-0.712\*) and minimum temperature (-0.753\*), while morning relative humidity (0.634\*) exhibited a positive significant relationship and evening relative humidity (0.494) showed positive but non-significant relationship. The rainfall effect was minimal (0.104). While the population of green lace wing revealed a significant negative correlation with maximum temperature (-0.764\*) and minimum temperature (-0.804\*), evening relative humidity (0.524\*) showed a significant positive effect. Morning relative humidity (0.674\*) showed a positive significant relationship and rainfall (0.114) effects were non-significant.

The correlation analysis between insect pests (Corn aphids and Wheat aphids) and their natural enemies in wheat during the *Rabi* seasons of 2023-24 and 2024-25 revealed highly significant positive relationships, indicating a strong dependence of predator populations on aphid abundance. Across both years, Syrphid Fly exhibited a very strong and consistent correlation with Corn aphids (r = 0.912\* in 2023-24; r = 0.937\* in 2024-25) and an even stronger association with Wheat aphids (r = 0.978\* in 2023-24; r = 0.937\* in 2024-25), indicated their high efficiency as a biological control agent, particularly against Wheat aphids. Similarly, Lady Bird Beetles showed a robust positive correlation with both aphid species, though their relationship was slightly stronger with Wheat aphids (r = 0.964\* in 2023-24; r = 0.982\* in 2024-25) compared to corn aphids (r = 0.872\* in 2023-24; r = 0.838\* in 2024-25). This indicates that lady bird beetles may have a greater preference for wheat aphids or are more effective in regulating their populations. Green Lacewing larvae also demonstrated significant and consistent positive correlations with both aphid species, with slightly higher values for Wheat aphids (r = 0.951\* in 2023-24; r = 0.963\* in 2024-25) than for Corn aphids (r = 0.843\* in 2023-24; r = 0.836\* in 2024-25), reinforcing their role as effective natural enemies in wheat fields.

The current study supported the findings of (8, 9, 10), who reported that through prey substitution, a high abundance of prey species other than the target pest (alternative prey) may reduce generalist predator predation on the pest. While no discernible correlation between the amount of alternative prey and the aphid clearance rate, it did rise with the abundance of generalist predators. When generalist predator abundance was not taken into account, a positive association between alternative prey richness and aphid removal rate was found due to the positive link between generalist predator abundance and alternative prey abundance. This implies that the impact of generalist predators replacing the pest with other food was minimal, and that the apparent correlation between the quantity of generalist predators and the effectiveness of biological control may be complicated by other variables. However, the current findings contrast with those of (11,12) who observed a peak population of aphids during the 2nd week of January and the 4th week of February. This might be due to the shift in meteorological conditions. Similarly, the study by (13) found that wheat aphids appeared during the first week of December and started to build up in January, peaking in March. The population declined in March due to increased temperature and crop maturity. (14) found that aphid prey, floral resources, and grass overwintering sites support natural enemies of cereal aphids. (15) reported a high incidence of aphids from December 2014 to February 2015, with a negative correlation with minimum temperature and humidity. They found a negative correlation with *Rhopalosiphum maidis* population. (16) found a negative correlation with minimum temperature and humidity. (17) identified six aphid species, with *Rhopalosiphum maidis* and *Rhopalosiphum* *rufiabdominalis* affecting vegetative and reproductive stages. Understanding these factors could help develop effective pest management strategies in climate change. They declined sharply, with natural enemies like syrphid fly, ladybird beetle, and green lacewing following similar trends. Weather parameters, such as temperature and relative humidity, significantly influenced the incidence of pests and natural enemies in wheat (18, 19).

**Table 1. Correlation between abiotic factors and natural enemies of aphids in wheat during *Rabi* 2023-24 and 2024-25**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Abiotic Factor** | **Syrphid fly** | | **Lady bird beetle** | | **Green lace wing** | |
| **2023-24** | **2024-25** | **2023-24** | **2024-25** | **2023-24** | **2024-25** |
| **Max. Temperature (°C)** | -0.824\* | -0.836\* | -0.712\* | -0.738\* | -0.764\* | -0.734\* |
| **Min. Temperature (°C)** | -0.854\* | -0.837\* | -0.753\* | -0.728\* | -0.804\* | -0.821\* |
| **Morning RH (%)** | 0.734\* | 0.764\* | 0.634\* | 0.692\* | 0.674\* | 0.637\* |
| **Evening RH (%)** | 0.584\* | 0.568\* | 0.494\* | 0.483\* | 0.524\* | 0.568\* |
| **Rainfall (mm)** | 0.144 | 0.126 | 0.104 | 0.114 | 0.114 | 0.117 |

Fig1: Correlation between syrphid fly, ladybird beetle, and green lacewing

**Table 2. Correlation between insect pest and their natural enemies in wheat during *Rabi* 2023-24 and 2024-25**

| **2023-24** | | | | **2024-25** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Corn aphids** | **r value** | **Wheat aphids** | **r value** | **Corn aphids** | **r value** | **Wheat aphid** | **r value** |
| Syrphid Fly | 0.912\* | Syrphid Fly | 0.978\* | Syrphid Fly | 0.937\* | Syrphid Fly | 0.937\* |
| Lady Bird Beetle | 0.872\* | Lady Bird Beetle | 0.964\* | Lady Bird Beetle | 0.838\* | Lady Bird Beetle | 0.982\* |
| Green Lace Wing | 0.843\* | Green Lace Wing | 0.951\* | Green Lace Wing | 0.836\* | Green Lace Wing | 0.963\* |

**4. CONCLUSION**

The stability of these correlations across two consecutive *Rabi* seasons indicated that these predator-prey interactions are well-established in wheat agroecosystems. The consistently high correlation values for all three natural enemies indicate that their populations closely track aphid infestations, making them reliable biological control agents. However, the slightly stronger associations with Wheat aphids compared to Corn aphids may reflect differences in prey preference, predation efficiency, or habitat suitability. These findings highlight the importance of conserving and enhancing populations of Syrphid Flies, Lady Bird Beetles, and Green Lacewings in wheat cultivation to promote sustainable pest management strategies. Further research could explore how abiotic factors such as temperature, humidity, and rainfall modulate these relationships to optimise integrated pest smanagement (IPM) approaches.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

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

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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