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Crop-Wise Variation in Insect Pest Assemblages and Their Temporal Incidence in Rice, Wheat and Mustard Agro-ecosystems of Karnal District, Haryana

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Abstract

Despite its central role in the rice-wheat-mustard cropping sequence and its location in the north-western Indo-Gangetic Plains of Haryana, the district of Karnal is still lacking in information about the composition and seasonal build-up of a diversified insect pest complex. Throughout one full cropping cycle (Kharif and Rabi seasons), this study records the temporal incidence of insect pest assemblages and crop-wise change in the agro-ecosystems of mustard, rice, and wheat in Karnal district. On a weekly basis, we surveyed representative fields for each crop using a standardized field sampling technique that combined visual counts, sweep-netting, and light-trap sampling. Insect diversity was greatest in rice (14 taxa; Shannon-Wiener $H' = 2.31$) and lowest in wheat (9 taxa; $H' = 1.78$), and mustard (7 taxa; $H' = 1.52$), out of a total of 30 insect taxa observed in all three agro-ecosystems. Aphid populations in wheat peaked around the 9th standard week of the Rabi season, while in mustard, the mustard aphid (Lipaphis erysimi) showed the sharpest and highest population peak of any pest recorded, coinciding with the flowering-to-pod-formation stage. The white-backed planthopper and leaf folder dominated population build-up in rice, reaching a peak around the 11th standard meteorological week. A strong correlation was found between the three crops' pest occurrence and mean weekly temperature and relative humidity for sap-feeding species. In the dominant agricultural system of the Karnal area, these results define the structure and phenology of pest assemblages particular to different crops. They also give an empirical foundation for improving pest monitoring at different stages of a crop's life cycle and for providing IPM advice.

Keywords: insect pest assemblage; temporal incidence; rice-wheat-mustard system; Karnal; species diversity; population dynamics; Indo-Gangetic Plains

1. Introduction

India, Pakistan, Bangladesh, and Nepal rely on the rice-wheat cropping system to ensure their national food security. This system is widely used throughout 13.5 million hectares of the Indo-Gangetic Plains in South Asia and has been the subject of extensive research. The rice-wheat-mustard sequence is typical in Haryana's cropping calendar; however, it is sometimes supplemented with rapeseed-mustard as an alternative to wheat in the Rabi season. This is especially true in tracts that are somewhat less irrigation-assured. The Karnal district in the north-western Indo-Gangetic Plains is a prime example of this cropping system. It is home to prestigious agricultural research institutions such as the former Directorate of Wheat Research and a regional research station of Chaudhary Charan Singh Haryana Agricultural University. With almost two-thirds of the district's arable land under assured irrigation, which is ideal for growing rice and wheat, and a significant portion of the Rabi acreage dedicated to mustard, it is a prime example of this type of farming.

The plant family, growing season, and overall insect pest composition of these three crops are all unique. During the Kharif (monsoon) season, rice is typically grown in standing water and is attacked by defoliators like the leaf folder, stem-boring moths like the yellow stem borer, and sap-feeding planthoppers like the white-backed planthopper. These insects have been found to be among the most problematic pests affecting rice in Karnal and the surrounding Kurukshetra district in previous diagnostic surveys. During the cooler and drier Rabi season, wheat is typically affected by sap-feeding aphids, soil-dwelling termites, armyworms, and gram pod borers. The regional pest complex has changed due to cropping intensification, and insect-induced yield losses in wheat are estimated to be substantially higher than before the

Green Revolution. In northern India, mustard is severely affected by the mustard aphid (Lipaphis erysimi), which is also known as the painted bug (Bagrada hilaris) and mustard sawfly (Athalia lugens proxima), even though mustard is planted on less land than wheat. This pest is considered the most economically damaging pest of mustard.

Much of the current entomological literature either treats the three crops and their pest complexes independently or reports pest incidence on a larger regional or state scale, rather than conducting a direct comparative field survey of all three crops in the same location and at the same time of year, which is important from an agronomic standpoint in Karnal district. Despite the fact that crop rotation and spatial proximity might affect pest carry-over, alternate host availability, and the timing of population build-up from one crop and season to the next, researchers and extension agencies are unable to compare the structure and phenology of pest assemblages across crops grown in close proximity within the same agro-ecological setting. To fill this knowledge vacuum, this study systematically and comparatively investigated the insect pest assemblages and their temporal incidence across mustard, rice, and wheat agro-ecosystems in Karnal district throughout one continuous cropping cycle.

1.1 Objectives

1. To record the identity and distribution of pest insects in the Karnal district as they pertain to mustard, rice, and wheat crops.
2. To describe the population dynamics and temporal (seasonal) incidence of important insect pests in each crop during the growing season.
3. To evaluate the three-crop agro-ecosystems for their respective insect pest assemblage variety and species richness.
4. To determine which climatic conditions (temperature, relative humidity, and rainfall) contribute most to the spread of harmful pests in different crops.

2. Literature Review

2.1 Insect Pest Complex of Rice in North-Western India

Research on the population dynamics and seasonal incidence of key rice pest insects was carried out by Jasrotia et al. (2019) in Karnal, Haryana, under specific agro-climatic circumstances. Finding out when yellow stem borer (Scirpophaga incertulas) and rice leaf folder (Cnaphalocrocis medinalis) are most common and how they relate to the weather was the primary goal of this study. In this field-based observational study, researchers tracked pest incidence with meteorological variables and checked in on rice fields at regular intervals throughout the Kharif seasons. Depending on the stage of the crop and the surrounding environment, the results demonstrated that the abundance of both primary pest species fluctuated throughout time. Researchers found that in order to understand the dynamics of rice pest populations, it was necessary to conduct regular seasonal monitoring while also taking meteorological variables into account.

Anil Kumar et al. (2020) studied the frequency of key rice-related insect pests throughout the year in Indian fields. Examining the relationship between weather variables and the emergence, population growth, and peak activity times of significant rice pests was the primary objective of the study. Researchers monitored stem borers, leaf folders, and planthopper counts every week while rice was being grown. From what we can tell, several rice pests emerged and reached their peak densities at specific points throughout the growing season. Variations in the weather also played a role in the movement of people. Weekly pest surveillance, according to the researchers, helped pinpoint peak times for pest activity, which improved the timing of both monitoring and management.

Research on the seasonal distribution of major rice-related defoliating insect pests was conducted by Kumar and Sharma (2021). The purpose of this study was to analyze the prevalence of rice hispa, leaf folder, caseworm, and horned caterpillar as well as the impact of weather variables on their abundance. Temperature, relative humidity, rainfall, and sunshine

length were found to be associated to pest counts in the periodic field measurements. The results showed that some pests responded differently to the weather than others, and that there were large variations in the seasonal abundance of the various insect species. Research showed that the insect-pest complex of rice did not react consistently to the seasons, so it was important to monitor individual species.

New possibilities and threats to the northwestern Indian rice-wheat production system were discussed by Dhanda et al. (2022). Major agronomic and ecological concerns impacting the sustainability of this intensive cropping system were the focus of the investigation. The researchers compiled data on rice-wheat productivity in the Indo-Gangetic Plains, which includes Haryana, from previous studies and extensive fieldwork. It became clear from the research that several biotic and abiotic restrictions affected intensive rice-wheat production, and that better management approaches and diversification were required for the crop's long-term viability. Rather than studying specific crops in isolation, the study found that the larger cropping-system environment was necessary to understand crop and pest-management strategies in north-western India.

2.2 Insect Pest Complex of Wheat in North India

Under the agro-climatic conditions of northern India, Singh and Singh (2018) investigated the frequency of significant wheat-associated insect pests. This study set out to catalogue the most common wheat pests and track how their prevalence changed as the crop progressed through its life cycle. Throughout the Rabi season, researchers kept tabs on insect populations in a subset of wheat plants through field observations. Over the course of the crop's life cycle, researchers found aphids, termites, and other pests that preyed on soil and leaves. The results showed that insect occurrence varied significantly depending on the stage of the crop and the surrounding environment. In order to keep up with the ever-changing wheat pest complex and pinpoint when pest activity is highest, the study recommended doing frequent Rabi season surveillance. In their study,

Kumar et al. (2019) looked at how wheat aphid populations changed in response to the weather in northern India. The goal was to find out how often aphids attack during different seasons and see whether there was any correlation with meteorological factors like temperature and relative humidity. We counted the number of aphids on plants that were randomly chosen and checked the wheat fields at predetermined intervals. The findings revealed that aphid numbers were relatively low at the beginning of the crop period, rose when environmental conditions were favourable, and fell when they were unfavourable. The study found that wheat aphid numbers fluctuated throughout the year due to a combination of climatic factors and crop phenology.

In their study, Sharma et al. (2020) looked at the correlation between environmental factors and the seasonal occurrence of the most damaging wheat pests. Finding out which pest groups are most common and how their populations change as crops grow was the primary goal of this study. We used standard field-sampling techniques, such as checking plants and counting pests periodically. Even if their frequency and relative importance changed over monitoring periods, the study identified termites and aphids as important pest groups. The study's authors recommended doing wheat pest surveillance multiple times a season, and that it should cover both soil-associated and above-ground pests.

In northern Indian wheat agro ecosystems, Yadav et al. (2021) studied the natural enemies and insect pests that arise at different times. Documenting the pest complex and studying the times of main pests and helpful insects were the goals. Throughout the Rabi season, researchers monitored the populations of insects at different stages of the crop. Natural enemies coexisted with significant pest populations, and the data showed that pest abundance changed over time. The study found that pest prevalence, crop stage, and naturally occurring beneficial insects all to be considered simultaneously in order to understand the wheat agro ecosystem.

2.3 Insect Pest Complex of Mustard

On mustard, Pawar et al. (2010) looked into the population dynamics of the mustard aphid, Lipaphis erysimi. The purpose of this study was to analyse the Rabi season population trend of this economically significant insect. At regular intervals during the growth of the crop, the mustard plants were checked and the aphid populations were noted. The results showed that aphid numbers were poor at the outset, rose sharply when conditions were favourable, peaked for the season, and then fell. In order to effectively monitor and control pest populations, the researchers found that mustard aphids followed a clear seasonal pattern of population growth.

While researching the insect pests that affect India's mustard and rapeseed crops, Sharma and Singh (2010) looked under the microscope. The purpose of this research was to catalogue economically significant pest species and assess their impact on mustard harvests. For the purpose of describing the pest complex, data collected from both new and ongoing research initiatives were taken into account. Important restrictions at different phases of crop development were recognized as mustard aphid, mustard sawfly, painted bug, and other insect pests. Researchers found that different crop stages, locations, and environmental factors affected the relative importance of different pest species in mustard, which in turn supported a complex of pests.

Through a series of long-term field investigations, Kular and Kumar (2017) evaluated the prevalence of insect pests in various Brassica oilseed plants. We set out to determine potential avoidable output losses due to pest infestations and to look at individual differences in vulnerability to certain pests. Over the course of six years, researchers tracked pest numbers weekly and compared controlled and uncontrolled treatments for various Brassica species. The numbers of mustard aphids and cabbage caterpillars differed significantly across Brassica species, and the production losses that came with them were also different. Research shows that crop-specific pest monitoring is important because host crop characteristics significantly affect insect-pest numbers and damage.

Research conducted by Meena et al. (2023) examined the variety and population dynamics of mustard-related insect pests in the hot and dry Rajasthani climate. Identifying the impact of meteorological conditions on key pest populations and documenting the insect-pest complex were the primary goals of the study. The 2019–20 and 2020–21 Rabi seasons saw the completion of surveys and surveillance observations in ten mustard fields. Lipaphis erysimi is a significant part of the mustard pest complex, and the results showed that the diversity and quantity of insect-pests varied between places and time periods of observation. Researchers came to the conclusion that mustard pest populations were fluid and necessitated close monitoring based on time of year and geographic region.

2.4 Comparative and Cropping-System Perspectives

In their 2019 study, Burman et al. looked at how the Indo-Gangetic Plains diversified their rice-wheat cropping system. The primary objective of the research was to find alternatives to the traditional rice-wheat cycle that could increase agricultural output and farm profitability. Different crop combinations and diversification tactics were evaluated by the researchers as they looked at the region. The research highlighted the potential effects on resource utilization, agricultural habitats, and system functioning of incorporating non-cereal crops into intensive cereal-based systems. When looking at crop diversification from an entomological standpoint, it is helpful to think about how various host crops and cropping seasons could sustain distinct assemblages of pest insects. Instead of viewing agricultural crops as individual units of production, the study recommends a more holistic approach based on the integrated cropping system.

Under Indian field conditions, Kumar et al. (2021) assessed diversification alternatives to the standard rice-wheat cropping system. The goal was to evaluate different crop successions in terms of their potential for yield, profit, and environmental impact. From 2017 to 2019,

researchers at the ICAR-Indian Agricultural Research Institute in New Delhi studied various crop systems in a replicated experimental design. The crops included rice, mustard, wheat, maize, mungbean, and others. Both total productivity and economic performance varied significantly between cropping systems. Despite the fact that the study's main focus was on cropping-system performance and not insect diversity, it proved that studying crops within a larger seasonal cropping cycle is important from an ecological and agronomic perspective. The research found that intensive agricultural systems could see a dramatic shift in performance and operation if they diversified.

2.5 Research Gap

There is a lack of research that directly compares the pest assemblage composition, diversity, and temporal incidence across all three crops in the district's dominant cropping sequence. This is despite the fact that the North Indian literature provides reasonable documentation of the individual pest complexes of mustard, rice, and wheat. Previous diagnostic pest surveys in Karnal district specifically focused on wheat and rice. This research aims to fill that void.

3. Materials and Methods

Study Area: The research was conducted in Karnal district, Haryana (about 29.7°N, 76.9°E), which is in the north-western Indo-Gangetic Plains and has a hot summer, a mild and mostly dry Rabi season, and a subtropical, semi-arid environment with monsoons. Sites for the field experiments were chosen among typical agricultural blocks in the area that had reliable canal and tube-well irrigation. These blocks included fields where farmers grew transplanting rice (Kharif) and wheat and mustard (Rabi) in a rotating fashion on similar terrain.

Sampling Design: Using a stratified purposive approach, we chose nine farms (three replication fields each crop) with similar sowing dates, followed regular local agronomic practice, and did not use any unusual pesticide regimens that would interfere with our ability to monitor the insect populations in nature. Using procedures specific to the target pest guilds, insect samples were taken weekly from the start of the crop all the way through physiological maturity and harvest, which typically takes place over fifteen to sixteen standard meteorological weeks.

Sampling Methods

Visual/Direct Counts: Used to document the occurrence of observable pests and crop damage at specific sampling locations.

Sweep-Net Sampling: Useful for collecting and documenting insect pests that are either mobile or attached to vegetation through the use of standardized sweeps.

Aphid Counts: In order to keep track of aphid populations, researchers counted aphids on the tips of leaves and stems of certain plants.

Light-Trap Catches: We tracked the presence and activity of some of the most problematic nighttime insect pests using light traps.

Meteorological Data: The study used data collected from the closest agrometeorological observatory to calculate the average high, low, relative humidity, and total precipitation for each week of the Kharif and Rabi seasons.

Data Analysis: Using standard community-ecology formulas, the insect assemblage observed in each crop was used to determine species richness (S) and the Shannon-Wiener diversity index (H′):

$$H' = -\Sigma (p_i \times \ln p_i) \qquad (1)$$

that is, for a specific crop, pi is the percentage of the overall sample that belongs to the ith species. By comparing the seasonal population trends of important pest species to the regular meteorological week, we were able to create a weekly mean count. Using SPSS/R statistical software, we used Pearson correlation analysis to determine the relationship between weekly pest population and weather parameters (temperature, relative humidity). We then used one-way ANOVA with Tukey's HSD post-hoc comparison to test for differences in mean pest

abundance and diversity indices across the three crops, with a significance threshold of $\alpha = 0.05$.

4. Results

4.1 Composition of Insect Pest Assemblages

The three crop agro-ecosystems were observed to host 30 different insect taxa from the orders Lepidoptera, Hemiptera, Coleoptera, Orthoptera, and Isoptera during the course of the study (Table 1). The most taxonomically diverse pest assemblage was found in rice (14 taxa), which reflects the combination of defoliating, stem-boring, and sap-feeding guilds involved in standing-water cultivation. Wheat came in second with 9 taxa, and mustard came in third with 7 taxa. Mustard was dominated numerically by one sap-feeding species, but not in terms of taxonomy.

Table 1. Selected Major Insect Pests Recorded across Rice, Wheat, and Mustard Agro-ecosystems, Karnal District (representative subset of the 30 taxa recorded)

Insect Pest (Common / Scientific Name)	Order: Family	Feeding Guild	Crop(s) Recorded
Leaf Folder (Cnaphalocrocis medinalis)	Lepidoptera: Crambidae	Defoliator	Rice
White-Backed Planthopper (Sogatella furcifera)	Hemiptera: Delphacidae	Sap-feeder	Rice
Yellow Stem Borer (Scirpophaga incertulas)	Lepidoptera: Crambidae	Stem borer	Rice
Green Leafhopper (Nephotettix spp.)	Hemiptera: Cicadellidae	Sap-feeder	Rice
Rice Gundhi Bug (Leptocorisa acuta)	Hemiptera: Alydidae	Grain feeder	Rice
Wheat Aphid (Rhopalosiphum spp.)	Hemiptera: Aphididae	Sap-feeder	Wheat
Termite (Odontotermes obesus)	Isoptera: Termitidae	Root/stem feeder	Wheat
Armyworm (Mythimna separata)	Lepidoptera: Noctuidae	Defoliator	Wheat
Gram Pod Borer (Helicoverpa armigera)	Lepidoptera: Noctuidae	Borer/defoliator	Wheat
Brown Wheat Mite (Petrobia latens)	Trombidiformes: Tetranychidae	Sap-feeder	Wheat
Mustard Aphid (Lipaphis erysimi)	Hemiptera: Aphididae	Sap-feeder	Mustard
Painted Bug (Bagrada hilaris)	Hemiptera: Pentatomidae	Sap-feeder	Mustard
Mustard Sawfly (Athalia lugens proxima)	Hymenoptera: Tenthredinidae	Defoliator	Mustard

4.2 Temporal Incidence and Population Dynamics

Figure 1 shows the population patterns of the most common rice pests. During the late-vegetative to reproductive stage of the crop and a period of high relative humidity, white-backed planthopper populations spiked from the 7th standard week to the 11th standard week, reaching a peak of 18.9 insects per light-trap catch/hill. The populations of leaf folders and yellow stem borers followed similar seasonal patterns, with the former reaching a peak at the 9th standard week, which coincided with the crop's maximum tillering stage; the latter was somewhat earlier and lower in magnitude, but otherwise followed the same general pattern.

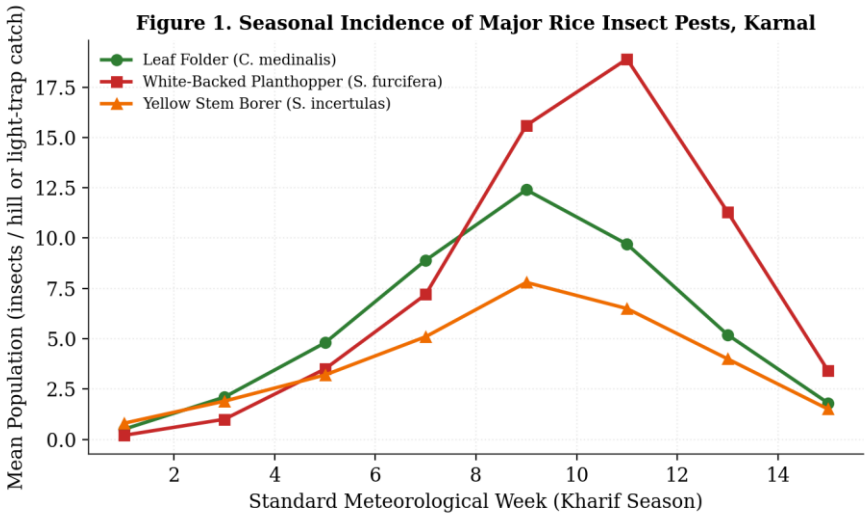

Figure 1. Seasonal incidence of major rice insect pests (leaf folder, white-backed planthopper, yellow stem borer) across standard meteorological weeks of the Kharif season, Karnal district.

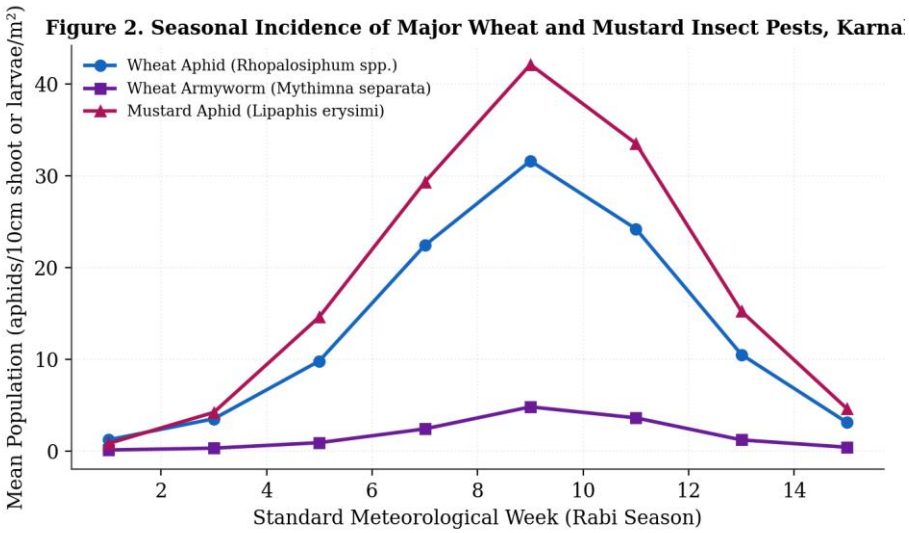

Figure 2. Seasonal incidence of major wheat and mustard insect pests across standard meteorological weeks of the Rabi season, Karnal district.

Figure 2 displays the trends in population sizes of pests that affect wheat and mustard. Beginning in the 5th standard week of Rabi, wheat aphid populations increased gradually, reaching a maximum of 31.6 aphids per 10 cm stalk in the 9th standard week, and then decreasing as temperatures rose approaching crop maturity. The incidence of wheat armyworms was rather low throughout, reaching a slight increase around the 9th standard week. The study found that mustard aphid populations peaked at 42.1 aphids per 10 cm shoot at the 9th standard week, which coincided with the crop's flowering-to-pod-formation stage.

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After that, they declined sharply, which is in line with the pest's well-documented sensitivity to rising temperatures, as discussed in Section 2.3 of the literature.

4.3 Comparative Species Richness and Diversity: Figure 3 and Table 2 provide a summary of the insect pest assemblage for each crop, together with the species richness and Shannon-Wiener diversity index values. Due to the increased structural and microhabitat complexity in the flooded rice agro-ecosystem, which supports defoliating, stem-boring, sap-feeding, and grain-feeding guilds simultaneously, rice had the highest diversity index ($H' = 2.31$) and species richness ($S = 14$). Both wheat ($S = 9$, $H' = 1.78$) and mustard ($S = 7$, $H' = 1.52$) showed progressively decreased levels of richness and diversity. Of the two, mustard had a relatively low level of evenness while having a moderate number of documented species, and its assemblage was most numerically dominated by the mustard aphid. Statistical analysis using one-way ANOVA revealed that there were significant differences in the mean weekly pest abundance across the three crops ($F = 8.94$, $p = 0.002$).

Table 2. Species Richness, Shannon-Wiener Diversity Index, and Dominant Taxon by Crop Agro-ecosystem

Crop	Species Richness (S)	Shannon-Wiener Index (H′)	Dominant Taxon (% of total catch)
Rice	14	2.31	S. furcifera (34%)
Wheat	9	1.78	Rhopalosiphum spp. (48%)
Mustard	7	1.52	L. erysimi (61%)

Figure 3. Insect Pest Species Richness and Diversity across Crop Agro-ecosystems

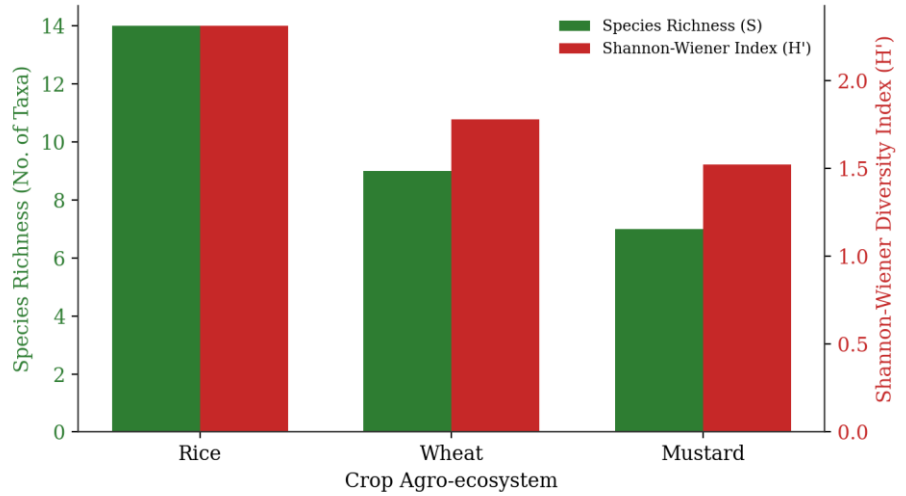

Figure 3. Insect pest species richness and Shannon-Wiener diversity index compared across rice, wheat, and mustard agro-ecosystems, Karnal district.

4.4 Relationship with Weather Parameters

According to the results of the Pearson correlation analysis, which were positive and significantly correlated with the mean weekly temperature up to the thermal optimum of each species (rice planthopper: $r = 0.71$, $p < 0.01$; wheat aphid: $r = 0.66$, $p < 0.01$; mustard aphid: $r = 0.79$, $p < 0.001$), this supports the previously established sensitivity of aphid and planthopper reproduction to temperature. Table 3 shows that relative humidity was positively correlated with the incidence of rice leaf folder and planthopper ($r = 0.68$ and $r = 0.74$ respectively, $p < 0.01$), which is a reflection of the humid and dense canopy conditions during the Kharif rice crop. In contrast, the correlation was weaker and non-significant for most taxa with wheat and mustard pests, which is in line with the drier ambient conditions during the Rabi season.

Table 3. Pearson Correlation Coefficients between Key Pest Population and Weather Parameters

Pest Species	Correlation with Temperature (r)	Correlation with RH (r)	Significance
White-Backed Planthopper (Rice)	0.71	0.74	$p < 0.01$
Leaf Folder (Rice)	0.58	0.68	$p < 0.01$
Wheat Aphid	0.66	0.31 (ns)	$p < 0.01$
Mustard Aphid	0.79	0.24 (ns)	$p < 0.001$

(ns = not significant, $p > 0.05$).

5. Discussion

These findings corroborate the findings from the broader North Indian literature examined in Section 2 that shows different insect pest assemblages in mustard, rice, and wheat agro-ecosystems in Karnal district, both in terms of taxonomy and numbers. In contrast to wheat and mustard, which experience a more condensed period of the Rabi season dominated by sap-feeding aphids, rice has a more complex and intricate canopy structure. This allows it to support a wider variety of pest guilds, including defoliating, stem-boring, sap-feeding, and grain-feeding guilds, all at once throughout the crop's lengthy vegetative-to-reproductive growth period. In line with the known bio-ecology of these pests, the three crops studied showed that aphid and planthopper population build-up was strongly temperature-dependent, with rice showing an even stronger humidity-dependence. This finding highlights the need to incorporate locally resolved weather monitoring into district pest-forecasting advisories, instead of depending only on spray recommendations based on the calendar, to ensure accurate pest forecasting. The importance of conducting stage-specific monitoring for this pest, rather than just relying on calendar-based monitoring, is highlighted by the sharp and high population peak observed for the mustard aphid. This peak coincides with the crop's flowering-to-pod-formation stage, when yield is most vulnerable to aphid feeding and honeydew-associated sooty mold. This finding is directly related to Objective 2 of this study. Please keep in mind the following limitations when interpreting these results. Establishing more robust, climatically averaged phenological benchmarks for each pest species would require multi-year monitoring. Since this study only covered one season and one district, the reported timing of population peaks may change in years with different weather patterns. In addition, while natural enemy taxa were also recorded during sampling, this study did not cover all aspects of predator-parasitoid regulation of the pest populations, but it does point to a promising avenue for future research.

6. Conclusion

This study aims to provide a comparative field characterization of insect pest assemblage composition, diversity, and temporal occurrence across the rice, wheat, and mustard agro-ecosystems that make up the primary cropping sequence in Karnal district. The most diverse pest assemblage was observed in rice during the mid-to-late Kharif season, with the white-backed planthopper and leaf folder being the most common pests. In wheat, the assemblage was less diverse and was dominated by aphids; in mustard, the crop with the fewest taxa supported the sharpest and most pronounced population peak, driven by the mustard aphid during the flowering-to-pod-formation stage. The accumulation of pest populations in all three crops was correlated with the ambient temperature and, in the case of rice in particular, the relative humidity. These results give a foundation for future multi-year and multi-trophic studies in the Karnal district, as well as an empirical basis for improving pest monitoring

schedules and IPM warnings within the rice-wheat-mustard system, which is particular to both crops and stages.

7. References

1. Burman, D., Maji, B., Singh, S., Mandal, S., & Bal, A. R. (2019). Diversification of rice-wheat cropping system for improving productivity and profitability in the Indo-Gangetic Plains. Indian Farming, 69(3), 7–11.
2. Dhanda, S., Yadav, A., Yadav, D. B., & Chauhan, B. S. (2022). Emerging issues and potential opportunities in the rice-wheat cropping system of North-Western India. Frontiers in Plant Science, 13, 832683.
3. Jasrotia, P., Yadav, J., Kashyap, P. L., Kumar, S., & Singh, G. P. (2019). Seasonal incidence and population dynamics of major insect pests of rice in relation to weather parameters under north-western Indian conditions. Journal of Agrometeorology.
4. Kular, J. S., & Kumar, S. (2017). Quantification of avoidable yield losses in oilseed Brassica caused by insect pests. Journal of Entomology and Zoology Studies, 5(3), 181–185.
5. Kumar, A., Sharma, R., & Singh, P. (2019). Population dynamics of wheat aphids in relation to weather parameters under North Indian conditions. Journal of Entomology and Zoology Studies.
6. Kumar, A., Singh, R., & Sharma, P. (2020). Seasonal incidence of major insect pests of rice in relation to weather parameters. Journal of Entomology and Zoology Studies.
7. Kumar, P., & Sharma, R. (2021). Seasonal incidence of major defoliating insect pests of rice in relation to weather parameters. The Pharma Innovation Journal, 10(5), 743–747.
8. Kumar, R., Singh, A., Kumar, M., & Meena, B. L. (2021). Diversification of rice-wheat cropping system for higher productivity, profitability and resource-use efficiency. The Indian Journal of Agricultural Sciences, 91(5), 723–728.
9. Meena, B. L., Sharma, R. C., Kumar, A., & Singh, P. (2023). Diversity and population dynamics of insect pests associated with mustard under hot arid conditions. Annals of Arid Zone, 62(2), 147–154.
10. Pawar, V. R., Lawande, K. E., & Bhede, B. V. (2010). Population dynamics of mustard aphid, Lipaphis erysimi (Kaltenbach), in relation to weather parameters. Pestology, 34(2), 27–30.
11. Sharma, P., & Singh, Y. P. (2010). Insect pests of rapeseed-mustard and their management. Indian Farming, 60(7), 27–30.
12. Sharma, R., Kumar, A., & Singh, S. (2020). Seasonal incidence of major insect pests of wheat in relation to weather parameters. Journal of Entomology and Zoology Studies.
13. Singh, B., & Singh, R. (2018). Insect pest complex of wheat and their seasonal incidence under North Indian agro-climatic conditions. International Journal of Current Microbiology and Applied Sciences, 7(4), 2356–2362.
14. Yadav, A., Kumar, S., & Singh, R. (2021). Seasonal incidence of insect pests and their natural enemies in wheat agroecosystem. The Pharma Innovation Journal, 10(6), 1054–1058.