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Agricultural Intensification's Impact on Crop Damage and Aphid Dynamics for Sustainable Pest Management

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Abstract*:*

Social pressure to produce more food, in addition to economic uncertainties and climate change, is continually compelling farmers to have embraced innovative crop production methods. However, persistent use of resource-intensive farming methods by farmers in an attempt to produce an abundance of food grains has led to deteriorating ecosystem services and functions as well as decreased soil health. Agricultural intensification is one such method, which entails increasing fertiliser input within fields and expanding cropland at landscape scales, meanwhile leading to biodiversity loss and the decline of natural enemies of agricultural pests such as aphids. Nevertheless, it can also be used constructively to inform sustainable and improved pest management strategies. Therefore, the present work has been proposed to review and examine the effects of agricultural intensification on crop damage patterns and aphid population dynamics from the perspective of their constructive use for sustainable pest management. This review will be of great interest to agricultural professionals working in the same area to understand the different strategies and constructively use agricultural intensification practices for improved pest management strategies.

Keywords: Agricultural Intensification, Mustard aphid, Population dynamics, Crop losses , and Sustainable Pest Management.

I. INTRODUCTION

Agricultural intensification is among the leading factors causing the loss of biodiversity and the shrinking of ecosystem services [1]. This process involves the expansion of cropland at the landscape level and the application of higher amounts of fertilisers within the fields.

The pest management strategy, which is considered to be sustainable, has now shifted towards habitat management, which is the best way to control pests biologically in the agricultural landscape with the aid of their structure [2]. The application of agrochemicals can have a profound impact on the arthropod communities within a field by affecting the plant's nutrition and this, in turn, can cause a rapid decrease of the biodiversity in the agroecosystem [3-5]. Different insects react differently to the changing host nutrition, hence the rising fertiliser input within fields has a different impact on insects. The ecological implications of the changes in agriculture have often drug out and heavy losses of crops. The good side of the nitrogen era in the rubber plantation has been the improvement of the plant's quality through the raising of the nitrogen in the leaves, and the sugars that dissolve which, in turn, directly leads to aphid's reproduction, survival, and population increase [6-7]. Experiments in cotton, melon, and peach show that the plants that are fertilised are the ones where aphids are developing faster and where more colonies are present [8]. In the case of monoculture systems, these effects coming from below are increased, allowing rapid colonisation and formation of the outbreak, which in turn causes more leaf damage, more virus transmission and hence loss of yield [9-10]The high inputs of the field moat range, however, the landscape scale by the reduction of crop diversity and semi-natural habitats. The cutting of hedgerows, grasslands, and the elimination of food resources for natural enemies of aphids and parasitoids brings down their number and their efficiency. Research has shown that landscapes where farming practices are simplified have a lower predation and parasitism rate which in turn leads to the weakening of the natural control of the aphid population [11]. [12-13] have shown a strong correlation between the occurrence of cereal aphids with the type of landscape composition, with matrices dominated by agriculture having more pest pressure. Analyses for longer periods indicate that the intensification of land use is responsible for making insect communities unstable and disrupting the networks of the food chain thereby reducing the biological control systems’ resilience. The above-mentioned ecological degradations do not only allow but even give rise to recurrent aphid outbreaks which in turn affect the human practice of using pesticides, thus creating a self-reinforcing cycle of chemical input and pest resurgence. By using chemical control, intensification has managed to reduce yield losses in a short period of time, however, this method typically conceals the basic weaknesses. The continuous application of insecticides may lead to a decline in the population of natural enemies and to the development of resistant biotypes of aphids, thus making the occurrence of secondary outbreaks and the failure of long-term control more likely. The consequent economic burden of increased chemical inputs, along with the environmental externalities, has raised doubts about the sustainability of pest management that is entirely based on input. Moreover, the interactions between climate and intensification that include drought stress in high-input systems can hinder the aphid population changes, leading to a more unpredictable pest pressure that is harder to control. The worldwide rapid pace of agricultural intensification is a concern that has made the understanding of its impacts on aphid dynamics and crop damage very urgent. Intensification has changed agroecosystems in such a way that they often favour aphid outbreaks by improving host-plant quality, simplifying habitats, and reducing the number of predators, thus increasing the vulnerability of crops to chemicals and making them dependent on chemical control. In the meantime, there are scattered indications that ecological measures taken in intensive systems can mitigate the impacts somewhat, but these findings are still not well spread across the different crops, regions and management scales. This review is made to combine the present knowledge on the interplay of different intensification aspects—nutrient inputs, cropping structure, and landscape simplification—with aphid population processes and crop damage. The review, by bringing together the evidence from field, farm, and landscape scales, highlights the common mechanisms responsible for pest escalation as well as the cases where responses vary with the context. It is very important to elucidate these patterns in order to shift from the use of pesticides as a reactive measure to the adoption of system-level solutions. The ultimate goal is to provide a coherent scientific basis for the redesign of intensive agriculture in such a way that productivity is not only maintained but also ecological regulation is restored, thus allowing for a transition to sustainable pest management.

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II. REVIEWED ARTICLE

Through chemical suppression, intensification has temporarily decreased yield losses, but it frequently hides underlying vulnerabilities. Frequent use of insecticides increases the risk of recurrent outbreaks and long-term control failure by eroding natural enemy populations and favouring resistant aphid biotypes. The sustainability of purely input-driven pest management is further called into question by the economic costs of rising chemical inputs and environmental externalities. Aphid dynamics can be further disrupted by intensificationdriven climate interactions, such as drought stress in high-input systems, making pest pressure more erratic and challenging to control.

The literature review's is underpinned by the comparative matrices that were created in this research, which expose distinct trends in crop types, methodologies, and spatial contexts used in the high and low crop areas in the literature. The crop-type matrix reveals that research is focused on cereals and fruit crops, whereas only a few studies are directed at vegetables and legumes. Thus, it is possible to pinpoint not only the leading research directions but also the existing gaps. The synthesis of the metrics-based approach proves that the majority of studies are based on measuring the population of aphids, harvest loss index, and the number of natural enemies, whereas the use of predator–pest ratios, economic outcomes, or long-term community stability is lesser. Similarly, the "demetries" table highlights that the research is being carried out at various spatial scales starting from lab experiments and plot-level field trials up to GIS and multi-year dataset landscape-scale analyses. All these tables together support a systematic investigation of how aphid population and crop damage are measured, where the evidence is, and how the scale affects the interpretation. By taking into account crop type, measurement approach, and study setting, this stage allows a systematic comparison of the impact of agricultural intensification on aphid pressure in the different systems, which proves that the conclusions are based on both methodological diversity and ecological context.

2.1 Type of crops under review articles

This section offers a systematic summary of the portrayal of various crop categories in the literature selected and points out the distribution of research focus in the field. The table, which divides the studies into cereals, legumes, fruit crops, vegetables, industrial crops, and mixed or general systems, allows for an easy visual comparison of the crop coverage and the research density. This integration shows a heavy scattering of studies in cereal and fruit systems which are economically important and their using-up being very frequent in intensive management and also the other way around for some vegetables and underrepresented legumes. The latter, even, the vegetable being the most vulnerable and the legume besides being fading out slowly is also the front area of the smallholder farmer-trader connection.

Hence,insecurity of future availability of contexts in which issues are dealt whole system-wise or concept-wise rather than crop specific is highlighted by the table as well as the dominating generalization over empirical evidence.

Table 1

Crop’s types under review articles

Author (APA)	**Cereals**	**Legumes**	**Fruit Crops**	**Vegetables**	**Industrial Crops**	**Mixed / General**
Aguilera et al., 2021	✓					
Perrot et al., 2021	✓					✓
Mwani et al., 2021	✓	✓				
Moreno-Delafuente et al., 2021				✓		
Török et al., 2021	✓					
Delaune et al., 2021	✓					✓
Serée et al., 2022		✓				
Courson et al., 2022	✓				✓	✓
Elkins et al., 2022						✓
Stell et al., 2022						✓
Alarcón-Segura et al., 2022	✓				✓	
Döring et al., 2022						✓
Doehler et al., 2023			✓			
Akter et al., 2023				✓		✓
Yang et al., 2023						✓
Liu et al., 2023					✓	
Bonato et al., 2023						✓

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Ziesche et al., 2024					✓
Klinnert et al., 2024					✓
Pitt et al., 2024					✓
Riggi et al., 2024	✓				✓
Herrera et al., 2024			✓		
Apple flower strip study, 2024			✓		
Zhou et al., 2024					✓
Altieri et al., 2024					✓
Sharma, 2024	✓				
Guo et al., 2024				✓	
Alfalfa landscape study, 2024		✓			
Borg et al., 2025			✓		
Thompson et al., 2025	✓				
Saleem et al., 2025	✓			✓	
Jia et al., 2025	✓				
Hatt et al., 2025					✓
Sagolla et al., 2025	✓				
Liu et al., 2025					✓
Howard et al., 2025 (EI economics)			✓		
Howard et al., 2025 (Margins)			✓		
Han et al., 2025			✓		
Lavandero et al.,					✓

2025				
Leroy et al., 2025			✓	✓
Poinas et al., 2025				✓
Poveda et al., 2025				✓
Boukhelouf et al., 2025	✓			
Adjalla et al., 2025	✓			
Cuenca-Medina et al., 2025		✓		
Uyi et al., 2025			✓	
Nakatani et al., 2025				✓
Sun et al., 2025				✓
Fenibo et al., 2025				✓
Gebretsadik et al., 2025				✓

This table acts as a crucial tool for synthesis by disclosing the concentration and imbalance of crop-related research in the literature reviewed. The dominance of cereals and fruit crops in the present studies indicates their economic importance and the commonality of aphid attack in intensive systems, while the low numbers of vegetables and legumes point to the existence of significant research gaps. The latter are especially important to consider since these crops are highly relevant for mixed cropping and sustainable farming systems and may exhibit different responses to the pressures of intensification. The table, by adequately delineating crop types against specific studies, reinforces the reviewing process of this paper, and thus, the interpretations of aphid movements and crop damage become more dependent on a clear awareness of the coverage of crops. It also elucidates the need to extend future research efforts beyond the dominant cropping systems. Hence, the table does not merely come up with a summarization of the available evidence but also points out the next steps of the analysis and the setting of research priorities, thereby stressing the importance of employing more inclusive and crop-diverse methods in the study of pest dynamics under agricultural intensification and sustainable pest management.

2.2 Review of intensification methods and findings

Agricultural intensification is a term that covers the whole spectrum of practices which, among others, include the use of more fertilizers and pesticides, the one-crop rotation system, the use of tractors, the greenhouses, and the simplification of the landscape. These practices are very common to increase the productivity but they also have a deep effect on the crops and the pests. It is known that the abundant nutrient regimes help to increase the quality of the host plant for aphids, while the simplified crop structures and the reduced habitat diversity cause weakening of the communities of natural enemies. As a result, the intensive management has been reported in many studies to be associated with the greater presence of aphids and the higher damage to the crops. However, at the same time, increasing evidence points out the possibilities of the alternative intensification pathways like the intercropping, flower strips, and habitat management—which both keep the yield level and lessen the pest pressure. This part of the paper looks at the main methods of intensification and their ecological and pest-related results.

Table 2:

Intensification methods and findings of reviewed articles

Sl No.	Author	Area of study	Intensification technique	Study setting	Key findings
1	Aguilera et al., 2021	Organic inputs & predators	Organic fertilization vers conventional technique	Field study	The generalist natural enemies or predators were believed to be reduced, or the aphid's tissue would now gain more control.
2	Perrot et al., 2021	Landscape composition & predation	Landscape grassland proportion	Landscape buffers (	At the landscape scale, the presence of more grassland resulted in higher ground-level aphid predation, which subsequently facilitated the significance of natural control in less

					intensive landscapes.
3	Mwani et al., 2021	Intercropping & field margins	Intercropping; margin vegetation diversity	Kenya; intercrop vs monocrop	Maize–dolichos intercropping + diverse border reduced Black Aphid pest damage as compared to monocrop.
4	Moreno-Delafuente et al., 2021	Plant chemistry & aphid performance	CO_2-driven plant nutrient dilution (linked to intensification/climate)	Controlled experiment	Plant nutrient shifts reduced aphid population growth (shows bottom-up effects from plant quality)
5	Török et al., 2021	Organic vs conventional trade-offs	Farming system intensity gradient	Field landscapes	Organic farming used some, but not all of mycotoxins to control pests, the biocontrol measures not always effective for the control of cereal aphids.
6	Delaune et al., 2021	Landscape drivers of pests	Land-use/landscape composition	Multi-crop database synthesis	The pressures of the pests in the landscape composition were explained; the impacts depended on the specific crop and pest, which guided the implementation of landscape-wide Integrated Pest Management (IPM).
7	Serée et al., 2022	Flower strips + management + landscape	Ecological intensification via flower strips; local management	France; multi-factor	Floral strips combined with altered context for aphids/natural enemies are highlighted for use, dependent on field and landscape management.
8	Courson et al., 2022	Weather vs landscape drivers	Regional intensification gradients	France; regional	The number of cereal aphids present was influenced by the weather and the type of the landscape (for instance,

				dataset	lower grassland proportion led to the reduction of aphids).
9	Elkins et al., 2022	Landscape complexity & biocontrol	Landscape complexity	Landscape-scale sampling	The augmentation of the complexity led to the increase of aphids and their enemies, but at the same time, there was a reduction in parasitism, which indicated the occurrence of non-linear intensification effects..
10	Stell et al., 2022	Drivers of aphid–enemy dynamics (review)	Intensification/climate/landscape drivers	Literature review	Intensification has a direct impact on the interactions between aphids and their natural enemies, and at the same time, it brings along some prediction challenges in integrated pest management (IPM) that need to be addressed.
11	Alarcón-Segura et al., 2022	Strip intercropping & parasitism	Spatial diversification (strip)	Field strips	Parasitism of aphids increased by strip intercropping
12	Döring et al., 2022	Aphid behaviour & nitrogen status	Nitrogen input (plant status)	Modelling + behavioural ecology	These shifts in aphid preference are suggested to be caused by the nitrogen content of the plants and thus the fertilizing regimes can be linked to the danger of colonisation.
13	Doehler et al., 2023	Landscape & greenhouse pest influx	Protected cropping expansion	France; 32 greenhouses	The landscape surrounding the greenhouses played a role in the colonization of pests and natural enemies, which to some extent, it was related to the intensification of the greenhouses through the use of the landscape.
14	Akter et al.,	Landscape	Landscape	Contine	In the field of biological control by

	2023	context & pests/enemies	mediation of pest/enemy abundance	nt-wide evidence	landscape context, this theory proposes that landscapes can also be managed or designed in a way to reduce pest pressure.
15	Yang et al., 2023	N fertiliser indirect environmental effects	N fertiliser intensification	Systems analysis	Herein, with this author in the mind field outlined N inputs' effect on crop-pest interactions.
16	Liu et al., 2023	Water stress × aphid dynamics	Drought stress (intensification/ climate stress)	Controlled study	Drought-phenomenon plant condition causes changes in cotton aphid dynamics. Stress suppression starts off at the most planted intensity.
17	Bonato et al., 2023	Landscape-scale pest control modelling	Landscape drivers; model transferability	9 sites; 5 countries	Typically landscape models do badly when applied to field pest control. Local calibration requires IPM.
18	Ziesche et al., 2024	Long-term intensification & insect communities	Land-use intensification	Long-term datasets	Enhancement of trophic connections and interactions would make the system more stable and, hence, instrumental in reducing aphid biocontrol in simplified systems.
19	Klinnert et al., 2024	Landscape features for natural pest control	Reduce pesticide reliance via LF-NPC	Large-scale evidence	Landscape features can replace portions of pesticide inputs, a cornerstone of sustainable intensification strategies.
20	Pitt et al., 2024	Crop diversity & aphid richness	Crop diversity vs simplified rotations	Buffers (e.g., 3 km)	Studies on lower aphid species rhythografic richness and higher crop diversity support the notion that range-diversification is typically effective and attractive over intensification practices.
21	Riggi et al.,	Expert-based	Intensive cereal	Temper	Provides linkage framework

	2024	NPC model in intensive cereals	dominance	ate intensive landscapes	concatenating field + landscape drivers to pest control potential in intensive systems.
22	Herrera et al., 2024	Ecological intensification in orchards	EI practices; reduced insecticides	Apple orchards	The EI alone does not help enhance aphid control due to the ant mutualism blocking biological control.
23	Flower strips in organic apple orchard (2024)	Floral strips & beneficials	Flower strips (EI)	Organic orchard plots	Although aphid control may vary, the flower-strip traits provide crucial environmental information; supporting the "design EP for beneficials.".
24	Zhou et al., 2024	IPM sustainability review	IPM vs chemical-intensive	Review	The evidence base of IPM has been augmented; this supports reducing pesticide intensity while maintaining pest suppression.
25	Altieri et al., 2024	Agroecological crop health	Diversity + soil microbial synergies	Review / perspective	Diversification and soil ecology provide a viewpoint to keep pest incidence low—not highly intensively.
26	Sharma (preprint), 2024	Floral strips near wheat	Floral strip habitat manipulation	Field proximity analysis	The beneficial insects were attracted by the florals strips; the predators might contribute to the suppression of aphids (still needs confirmation through multi-year studies).
27	Guo et al., 2024	N input & cotton aphid	Nitrogen fertilisation intensity	Controlled experiment	There were benefits to aphids with high and low N, and an increased risk of aphids was detected..

28	Landscape structure & aphid biocontrol in alfalfa (2024)	Landscape effects on biocontrol	Landscape composition/configuration	3 regions	The impact of landscapes on pest control was not the same across different regions; in most cases, non-crop habitats provided some help to the natural enemies, but the final results were variable.
29	Borg et al., 2025	N fertiliser × cover crop VOCs	Nitrogen + peppermint ground cover	Field factorial	An increase in N could lead to higher infestation risks; the peppermint cover mediated the aphid dynamics through VOC effects.
30	Thompson et al., 2025	Strip cropping arrangement	Strip cropping vs patches	2022–2023	A higher predation rate can be recorded in strips of wheat despite the fact that aphid abundance remains unchanged, which contributes to the better biocontrol function.
31	Saleem et al., 2025	Canola–wheat intercropping	Strip/alternate-row intercropping	Pakistan; 2021 & 2023	Potential of aphids were lowered by intercropping on alternate rows and even increased their natural enemies in organic farming, where, in the case of conventional production, the input was lowered by 5 % despite increasing again by 17%.
32	Jia et al., 2025	Agroforestry intercropping	Intercropping system	Field intercropping	The practice of intercropping has had an impact on the predator communities of that particular area and has the ability to control aphid populations in the crops that are grown alongside.
33	Hatt et al., 2025	Intercropping + wildflower strips	Combined EI tactics	Field system	Combining intercropping with wildflower strips strengthened biological control and system performance.

34	Sagolla et al., 2025	Agroforestry (alley cropping)	Tree rows in cropping system	Germany	Due to the proximity of the tree rows, aphid predation is high, whereas agroforestry can boost pest regulation.
35	Liu et al., 2025	Predator:pest ratio as indicator	Landscape intensification framing	Landscape-level study	Lethal control techniques against aphid populations by the natural enemy were compared with demographic structuring to determine optimal perturbation strategies for pest reduction at the regional scale..
36	Howard et al., 2025	Bio-economic EI assessment	Perennial flower strips	Orchards; economic modelling	Flower strips can play a role in reducing the damage caused by the rosy apple aphids and may thus be cost-effective against the dependence on chemical insecticides.
37	Howard et al., 2025	Flower margins mechanisms	Flower margins adjacent to orchards	Orchard habitats	Growing flowers on the margins depressed spreading of aphid and lowered fruit damage percentages with a boost to the natural enemies.
38	Han et al., 2025	Flower strips in pear orchards	Flower strips	Orchard study	Bee-flower strips increased natural enemies and biocontrol services—thereby aiding in the suppression of aphids in orchards.
39	Lavandero et al., 2025	Farm-scale EI × landscape	Flower strips + % semi-natural habitat	14 farms; SNH gradient	There was a negative effect of flower strips + more SNH on the number of aphids and a positive one on parasitoid mummies.
40	Leroy et al., 2025	Multifunctionality in OSR landscapes	Semi-natural habitat effects	Landscape-scale	The secondary habitats have a partial influence on other functions, with respect to aphid control too.

41	Poinas et al., 2025	Netting landscape externalities	Exclusion netting expansion	Landscape study	The higher proportion of netting had an impact on pest dynamics not only in individual farms but in whole landscapes- a factor that is important to consider in the planning of intensification.
42	Poveda et al., 2025	Global synthesis of landscape → pests → yield	Agriculture-dominated landscapes	Global synthesis	Tested hypotheses: natural areas → enemies ↓ pests; agriculture ↑ pests; landscape affects yield directly/indirectly.
43	Boukhelouf et al., 2025	Intensification & insect diversity	Orchard intensification gradient	Date palm systems	Intensification has transformed the treating insect community; repercussions on natural control in orchard.
44	Adjalla et al., 2025	Natural enemies for aphid control (review)	Reduced chemical reliance	Systematic review	The management intensity significantly impacts the effectiveness of the enemy and thus supports the use of agroecological management of aphids as a method of disease control.
45	Cuenca-Medina et al., 2025	Biocontrol tools	IPM using endophytes	Greenhouse	Endophytic agents could be a potential biological alternative to chemical-intensive management.
46	Uyi et al., 2025	Insecticide × host resistance × N	Chemical control + N level	Field trials	Insecticide treatment heavily reduced aphids, but nitrogen levels and genotypes influenced infestation and resurgence of these pests.
47	Nakatani et al., 2025	Fertilisation & aphid population growth	Fertilisation intensity	Controlled experiment	Within the species tested, fertilization retarded aphid growth, indicating that the direction of the response can be species/system-dependent.
48	Sun et al.,	Service plants	Habitat	39	Those plants are recognized as service

	2025	for enemies	manipulation	plant species; 2020–2021	plants for aphid natural enemies—EI outreach for intensive landscapes.
49	Fenibo et al., 2025	Biopesticides & sustainability	Replace chemical-intensive control	Review	Biopesticides provide a lessening of chemical reliance, which contributes to sustainable pest-management trajectories that are less harmful as compared to intensification.
50	Gebretsadik et al., 2025	Plant resistance & intensification link	Biodiversity loss/intensification context	Review	The presence of natural predators has been found to become less effective when biodiversity diminishes and the land use practices are intensified. This situation advocates for the application of integrated techniques.

Table 2 provides a complete overview of the studies under review, by incorporating the authors, the methods of intensification applied, the materials and metrics used, the locations of the studies and the main findings. This synthesis of the literature indicates that there are no differences between systems and scales in the examination of agricultural intensification. Biological indicators such as the number of aphids, the number of predators and the amount of crop damage are the main measurement techniques of most studies so that the management of the area has a strong impact on the ecosystem and its responses. The majority of the studies are based on-field experiments; nevertheless, a considerable amount of research is devoted to analyzing the whole landscape, which indicates the increasing awareness that the pest population is influenced not only by one farm but also by the whole area around it. The table also implies that intensification is not only confined to the use of input-based practices such as fertilizers and pesticides but increasingly encompasses structural alterations like monoculture, greenhouse expansion, and habitat simplification. A common trend of the negative effects, of the increased pest populations and the higher extents of crop damage, especially in the cases where the natural enemy's communities are suppressed, is observed in all the crops and regions. However, the table incorporates the evidence of other ways of intensification, such as intercropping, flower strips, and agroforestry, that reduce the mentioned harmful impacts through the restoration of natural balance. This table, by placing methods and outcomes side by side, offers a clear picture of the ways how the intensification strategies provoke pest responses. Thus, it is the empirical foundation of the review, which allows for the systematic interpretation of the patterns and trade-offs that are the basis for the transition to the more resilient and sustainable pest management systems.

2.3 Review of material and demerits

The review of materials and demetries establishes a methodological basis for understanding the agricultural intensification and aphid dynamics research across various agroecosystems. The chosen studies incorporate a broad range of materials and metrics such as aphid population sizes, crop damage indices, densities of predators and parasitoids, characteristics of plant nutrition and the composition of the landscape. These are used within different demetries from laboratory experiments and small-scale field trials to farm and landscape assessments using GIS and analysing data from several years. This variety shows the intricate nature of pest processes and the multiple scales of intensification. By combining these methods, the review points out the impact of measurement choices and spatial context on the interpretations of pest risk and management effectiveness.

Table 3:

Materials under review

Materials / Metrics Used	Demetrie	Author details
Aphid abundance, density, population growth rate	Field plots; multi-season cereal, cotton, orchard and vegetable systems	Aguilera et al., 2021; Mwani et al., 2021; Serée et al., 2022; Courson et al., 2022; Elkins et al., 2022; Liu et al., 2023; Guo et al., 2024; Borg et al., 2025; Saleem et al., 2025; Uyi et al., 2025
Crop damage indices (leaf damage, yield loss, fruit	On-farm trials in orchards and cereals	Mwani et al., 2021; Herrera et al., 2024; Howard et al.,

injury)		2025; Han et al., 2025; Adjalla et al., 2025
Natural enemy abundance (predators, parasitoids)	Field and orchard habitats; strip/intercrop and margin experiments	Aguilera et al., 2021; Serée et al., 2022; Alarcón-Segura et al., 2022; Doehler et al., 2023; Akter et al., 2023; Pitt et al., 2024; Sharma, 2024; Sun et al., 2025
Parasitism rate / mummy counts	Cereal fields, orchards, flower-strip systems	Alarcón-Segura et al., 2022; Serée et al., 2022; Lavandero et al., 2025; Howard et al., 2025
Predator : pest ratio	Landscape-scale field networks	Liu et al., 2025; Klinnert et al., 2024
Predation rate (sentinel prey, seed/aphid removal)	Landscape buffers (250 m–3 km), strip cropping, agroforestry	Perrot et al., 2021; Thompson et al., 2025; Sagolla et al., 2025
Landscape composition metrics (grassland %, SNH %, crop diversity, patch size)	GIS-based buffers around fields/farms (500 m–3 km)	Perrot et al., 2021; Delaune et al., 2021; Courson et al., 2022; Akter et al., 2023; Pitt et al., 2024; Poveda et al., 2025; Leroy et al., 2025
Plant nutrient status (N content, C:N ratio, sugars)	Controlled environment or fertiliser gradient experiments	Moreno-Delafuente et al., 2021; Döring et al., 2022; Yang et al., 2023; Guo et al., 2024; Nakatani et al., 2025
Plant chemical traits / VOCs	Orchard and greenhouse trials	Moreno-Delafuente et al., 2021; Borg et al., 2025; Cuenca-Medina et al., 2025
Weather & climatic covariates	Regional datasets across cropping zones	Courson et al., 2022; Stell et al., 2022

Insect community diversity (Shannon, richness, evenness)	Long-term agricultural landscapes and orchards	Ziesche et al., 2024; Boukhelouf et al., 2025; Pitt et al., 2024
Economic metrics (cost–benefit, yield vs control cost)	Orchard systems under EI vs conventional management	Howard et al., 2025; Klinnert et al., 2024
IPM / ecological intensification indicators (review synthesis)	Narrative and systematic reviews	Zhou et al., 2024; Altieri et al., 2024; Fenibo et al., 2025; Gebretsadik et al., 2025
Model outputs (SEM, predictive NPC models)	Multi-country datasets; meta-analyses	Bonato et al., 2023; Riggi et al., 2024; Poveda et al., 2025

The combined materials and demetries give us an insight into the interaction between aphid pests and the resulting crop damage, which is affected by the method of measurement and the size of the area where the phenomenon is studied. This integration of different approaches makes it impossible to interpret the impacts of intensification on pest management without taking into account the specific circumstances, thereby enlarging the field of evidences for the designing of powerful and resilient Sustainable Pest Management schemes.

III. CONCLUSIONS

This paper indicates that the intensification of agriculture has a major impact on the aphid population and the extent of the crop damage caused by the aphids due to its effects on host-plant quality, the structure of cropping systems and the reduction of the natural mechanisms that keep the pest populations at a minimum. The merging of proof via the structured tables reveals that there are common trends seen throughout crops, regions, and methods: the systems that are more intense encourage the aphids to grow, make the crops more vulnerable and rely more on chemical control. Alternatively, the review points out that paths of intensification like intercropping, flower strips, agroforestry, and moderated input regimes can bring back some aspects of the ecological balance while the productivity is maintained. This research, through the combination of crop type, materials, demetries and outcomes, not only discloses the area of current knowledge but also the area of critical gaps left. These revelations highlight the importance of switching the traditional input-driven pest suppression method to system-level redesign. Diversity, landscape context and biological regulation must be the main focus of future research and practice if pest risk is to be minimised in an environmentally friendly manner. The findings, finally, give a scientific basis for the reorientation of the intensive agriculture towards resilient, ecologically informed and Sustainable Pest Management systems.

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