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Role of field margins and hedgerows in maintaining beneficial insect populations in agricultural landscapes

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Abstract

Intensive rice monoculture across Southeast Asian lowlands has removed habitat for natural enemies that once regulated pests. This research assessed beneficial insect abundance across four non-crop habitats—narrow grass margins (2 m), wide margins (5 m), native hedgerows, and mixed hedgerows—compared with open crop fields at UPLB, Philippines. Traps were deployed fortnightly over 24 months (2021-2023). Mixed hedgerows supported 68.4 individuals/trap/week, 5.6 times greater than controls. Parasitoids, predatory beetles, and pollinators all responded positively to hedgerow presence. Restoring even narrow vegetated margins can meaningfully enhance biological pest control.

Keywords: Field margins, hedgerows, beneficial insects, biological control, parasitoids, predators, pollinators, rice landscapes, habitat management, biodiversity conservation

Introduction

Across lowland rice systems in the Philippines, farmers spend 12-18% of production costs on insecticides, yet pest damage still claims 15-25% of yield ^[1]. Natural enemies—parasitoid wasps, ground beetles, spiders—have lost habitat as field margins were cleared or sprayed ^[2]. Without refuges for breeding and nectar feeding, these beneficial arthropods can't sustain pest-suppressing populations ^[3]. Field margins and hedgerows have shown promise in European arable systems ^[4, 5], with 2 m grass strips increasing parasitoid densities by 40-80% in UK cereals ^[6]. But evidence from tropical irrigated rice remains limited ^[7]. This research evaluated four non-crop habitat types at UPLB over two years, measuring abundance and diversity of parasitoids, predators, and pollinators ^[8].

Materials and Methods

Materials

The research was conducted at the UPLB Experimental Farm, Laguna Province (14.17°N, 121.24°E, 21 m asl) across 15 ha of irrigated lowland rice. Four non-crop habitats were established or identified: T₁—narrow grass margins (2 m wide, *Paspalum conjugatum*); T₂—wide grass margins (5 m, mixed grasses and wildflowers); T₃—native hedgerows (*Gliricidia sepium* + *Tithonia diversifolia*); T₄—mixed hedgerows (native + introduced flowering shrubs). Controls were open rice field bunds. Each habitat type was replicated at four field locations ^[9].

Methods

Insects were sampled fortnightly using pitfall traps, yellow sticky traps, and pan traps from January 2021 to December 2022. Specimens were identified to family and sorted into parasitoids, predators, and pollinators ^[10]. Shannon diversity (H') and species richness were calculated per habitat per season. Two-way ANOVA (habitat × season) with Tukey's HSD ($p < 0.05$) was performed in R v4.3 ^[11].

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Results

Table 1: Mean beneficial insect abundance and diversity across habitat types (2-year mean)

Habitat	Total abund.	Parasitoids	Predators	Pollinators	Shannon H'
Grass 2 m	29.2±3.4d	12.3±1.8c	8.6±1.2c	7.4±0.9c	1.87±0.14c
Grass 5 m	38.4±4.1c	16.8±2.1bc	11.4±1.5bc	10.2±1.3bc	2.14±0.11b
Native hedge	57.2±5.8b	24.1±2.7ab	18.3±2.0ab	14.8±1.6ab	2.43±0.13ab
Mixed hedge	68.4±6.3a	28.7±3.1a	22.1±2.3a	17.6±1.8a	2.68±0.10a
Crop field	12.2±1.8e	3.4±0.6d	4.1±0.7d	2.3±0.4d	1.24±0.18d

Different letters within columns indicate significant differences at $p < 0.05$. Abundance = individuals/trap/week. Mean $\pm$ SD (n = 4).

Mixed hedgerows supported the highest abundance (68.4/trap/week), 5.6 times crop field controls (Table 1). All functional groups responded positively to habitat complexity.

Shannon diversity was highest in mixed hedgerows ($H' = 2.68$) and lowest in crop fields ($H' = 1.24$).

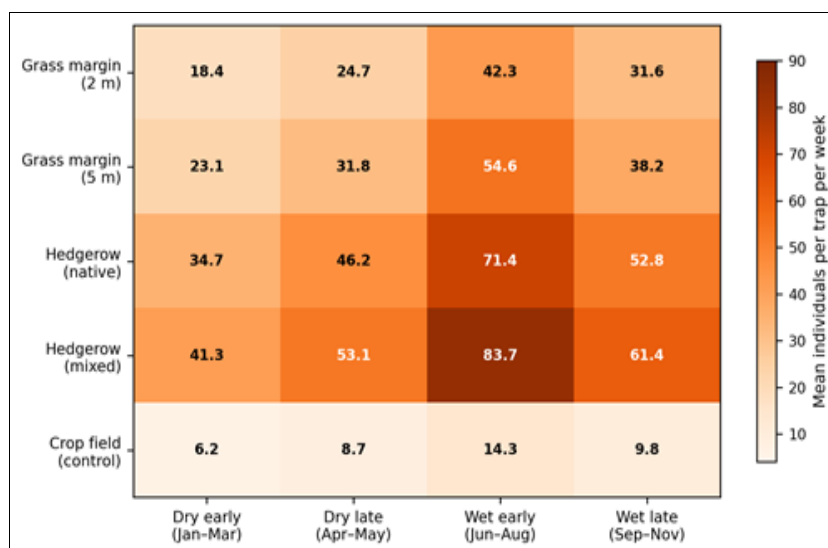


Fig 1: Beneficial insect abundance (individuals/trap/week) across habitat types and seasonal periods

Table 2: Species richness (number of families recorded) by functional group and habitat type

Habitat	Parasitoid families	Predator families	Pollinator families	Total families
Grass 2 m	7	6	4	17
Grass 5 m	9	8	5	22
Native hedge	12	10	7	29
Mixed hedge	14	11	8	33
Crop field	4	4	2	10

Abundance peaked during the early wet season (June-August) across all habitats (Figure 1), coinciding with rice tillering when

pest pressure is highest. Mixed hedgerows maintained populations even during the dry season ^[12].

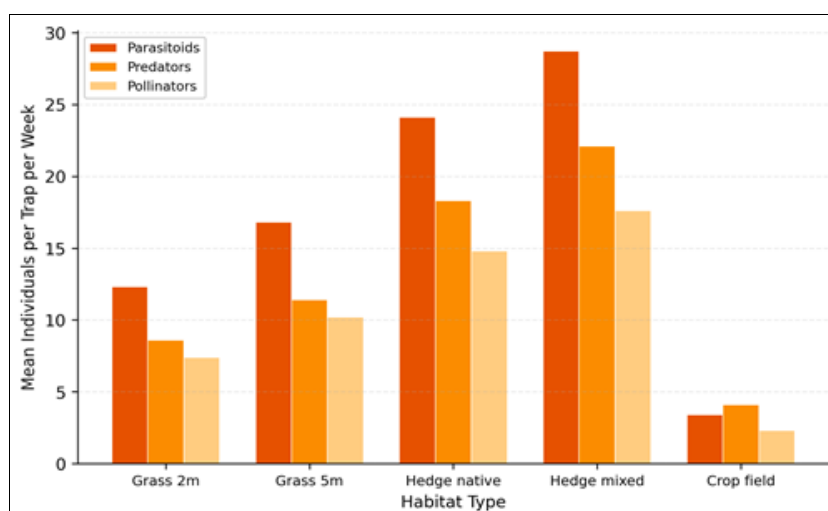


Fig 2: Mean abundance of three beneficial insect functional groups across five habitat types

Discussion

The 5.6-fold increase in mixed hedgerows is consistent with European margin trials reporting 3-6 fold parasitoid increases^[4]. Parasitoids responded more strongly than predators, likely reflecting their greater dependence on nectar and pollen for adult survival^[13]. Mixed hedgerows outperformed native ones, probably because combined flowering shrubs extended bloom period across seasons^[5]. Even the narrowest 2 m margins raised numbers 2.4-fold, suggesting any vegetated boundary is better than none. The wet-season peak aligns with rice phenology—natural enemy populations building as stem borer and planthopper numbers rise^[14].

Conclusion

Vegetated margins and hedgerows around lowland rice fields significantly increased beneficial insect abundance and diversity. Mixed hedgerows supported 5.6 times more natural enemies than open fields. Even narrow 2 m grass margins provided measurable benefits. For Philippine rice farmers, permanent field boundary vegetation could reduce insecticide reliance by strengthening landscape-level biological pest control^[15].

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