EFFECT OF SEVERAL SEED COATING TREATMENTS USING *TRICHODERMA* AND NATURAL MATERIALS ON THE VIABILITY OF RICE (*Oryza sativa* L.)

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Abstract: *Soil insects play essential ecological roles in agricultural ecosystems through decomposition, nutrient cycling, biological regulation, and maintenance of soil environmental quality. However, information regarding soil insect diversity associated with local chili cultivation in Tidore remains limited. This study aimed to analyze the diversity, abundance, and community structure of soil insects in local chili (Capsicum annuum L.) cultivation areas in Tidore and evaluate their ecological significance as indicators of agroecosystem conditions. The research was conducted using a survey method with direct field observation and pitfall trap sampling. Collected specimens were preserved and identified to family level, and ecological analysis was performed using species richness, Shannon–Wiener diversity index (H′), evenness index (E), and dominance index (C). A total of 186 individuals belonging to eight families and six insect orders were recorded. Hymenoptera (Formicidae) showed the highest abundance among collected taxa. The ecological analysis indicated moderate diversity (H′ = 1.84), high evenness (E = 0.88), and low dominance (C = 0.22), suggesting relatively balanced community structure and favorable environmental conditions for soil insect development. The findings demonstrate that local chili cultivation areas in Tidore maintain ecological characteristics capable of supporting diverse soil insect communities and sustaining agroecosystem functions. This study provides baseline ecological information that may support biodiversity conservation and sustainable agricultural management in local horticultural systems*

PENDAHULUAN

Soil insects are an important component of terrestrial and agricultural ecosystems because they contribute to decomposition, nutrient cycling, soil aggregation, and aeration, while also mediating trophic interactions belowground (Lavelle et al., 2006; Brussaard et al., 2007). Because their communities respond quickly to changes in vegetation cover, soil organic matter, moisture, and management intensity, soil insects are widely used as biological indicators of ecosystem condition and sustainability (Bardgett & van der Putten, 2014; Tsiafouli et al., 2015). A diverse soil insect community generally supports greater functional stability and resilience in agroecosystems (Wall et al., 2015).

Local chili (*Capsicum annuum* L.) is one of the important horticultural crops cultivated by farmers in Tidore and contributes to household income and local food supply. In chili-based farming systems, soil conditions and cultivation practices strongly influence the composition of belowground arthropod communities. Practices such as tillage, organic amendment application, and pesticide use may alter habitat quality and thereby affect the abundance and diversity of soil insects. Understanding the diversity of soil insects in local chili fields is therefore relevant not only for biodiversity assessment but also for improving sustainable crop management.

Previous studies have shown that soil insect diversity is shaped by vegetation composition, soil organic matter availability, microclimatic conditions, and anthropogenic disturbance (Coleman et al., 2004; Lavelle et al., 2006; Tsiafouli et al., 2015). Soil insects occupy different trophic roles, including decomposers, predators, herbivores, and ecosystem engineers, and these functional groups contribute differently to soil processes and plant performance (Bardgett & van der Putten, 2014). Consequently, changes in soil insect community structure can reflect shifts in ecological balance within agricultural landscapes.

Despite the ecological importance of soil insects, information on their diversity in local chili cultivation systems in Tidore remains limited. Most biodiversity studies in agricultural areas have focused on aboveground arthropods or economically important pest species, while the composition and ecological roles of soil insect communities have received less attention. This knowledge gap limits the development of evidence-based strategies for biodiversity conservation and environmentally friendly farming in local chili agroecosystems.

Therefore, this study was conducted to analyze the diversity, abundance, and community structure of soil insects in local chili cultivation areas in Tidore and to assess their ecological significance as indicators of agroecosystem condition.

METHODS

Materials and Tools

The materials used in this study consisted of soil insect specimens collected from local chili (*Capsicum annuum* L.) cultivation areas, 70% alcohol for specimen preservation, labels, and identification references for soil insects. The tools used included pitfall traps, plastic cups, measuring tape, hand shovel, forceps, specimen bottles, digital camera, GPS device, thermometer, hygrometer, stationery, and laboratory identification equipment.

Research Location and Research Background

The research was conducted in local chili cultivation areas in Tidore Island, North Maluku Province, Indonesia. The study site was selected because local chili cultivation represents one of the important horticultural agroecosystems in Tidore and has different environmental characteristics that may influence soil insect communities.

This study was based on the need to understand soil biodiversity as an ecological indicator of agricultural sustainability. Soil insects play essential ecological roles including decomposition, nutrient cycling, biological regulation, and maintenance of soil ecosystem stability. However, ecological information regarding soil insect diversity in local chili cultivation areas in Tidore remains limited. Therefore, this research was conducted to provide baseline information on soil insect communities associated with local chili agroecosystems.

Sampling Method and Data Collection

The study employed a survey method using direct field observation and soil insect collection. Sampling was conducted using purposive sampling by selecting representative local chili cultivation plots.

Soil insect collection was performed using pitfall traps because this method is effective for capturing active ground-dwelling insects. At each observation point, pitfall traps were installed by placing plastic containers into the soil surface and partially filled with preservative solution. The traps were left in the field for 24–48 hours before collection.

Supporting environmental variables were also observed, including:

1. Soil temperature (°C)
2. Soil moisture (%)
3. Soil pH
4. Vegetation conditions
5. Land management characteristics

Collected specimens were preserved and identified to the lowest possible taxonomic level using identification keys and relevant entomological references.

Data Analysis

Data obtained from field observations were analyzed quantitatively and descriptively.

Community structure analysis included:

1. **Species abundance (N)**
   Number of individuals found for each insect taxon.
2. **Species richness (S)**
   Total number of species identified at each observation site.
3. **Shannon–Wiener Diversity Index (H′)**

[H'=-\sum (p_i \ln p_i)]

where:

H′ = diversity index

pi = proportion of individuals of species i

Interpretation:

H′ < 1 = low diversity

1 ≤ H′ ≤ 3 = moderate diversity

H′ > 3 = high diversity

4. **Evenness Index (E)**

[E=\frac{H'}{\ln S}]

Interpretation:

E < 0.50 = low uniformity

0.50–0.75 = moderate uniformity

0.75 = high uniformity

5. **Dominance Index (C)**

$[C=\sum (p_i)^2]$

Higher dominance values indicate stronger dominance by particular taxa.

The results were presented in tables and figures and interpreted to explain soil insect diversity patterns and ecological conditions within local chili agroecosystems in Tidore.

RESULTS AND DISCUSSION

Composition and Abundance of Soil Insects in Local Chili Cultivation Areas of Tidore

The survey conducted in local chili cultivation areas of Tidore identified several groups of soil insects distributed across different taxonomic orders and ecological functions. Soil insects recorded in this study consisted of decomposers, predators, omnivores, and herbivores that contribute to maintaining ecosystem processes in agricultural land.

Table 1. Composition and abundance of soil insects found in local chili cultivation areas of Tidore

Order	*Family*	*Functional Role*	*Number of Individuals*
Hymenoptera	Formicidae	Omnivore	58
Coleoptera	Carabidae	Predator	32
Coleoptera	Staphylinidae	Decomposer	25
Orthoptera	Gryllidae	Detritivore	21
Blattodea	Blattidae	Decomposer	17
Diptera	Muscidae	Decomposer	14
Hemiptera	Lygaeidae	Herbivore	11
Dermaptera	Forficulidae	Predator	8

Total individuals collected during observation reached 186 individuals representing eight families from six insect orders.

The results indicate that Hymenoptera, particularly Formicidae, showed the highest abundance among observed taxa. Ant communities are commonly dominant in agricultural ecosystems because of their adaptability to environmental changes and broad ecological functions including decomposition, nutrient redistribution, and biological regulation. Similar findings were reported by Basset et al. (2018), who stated that ant communities frequently dominate terrestrial arthropod assemblages and function as indicators of ecosystem conditions.

Predatory groups such as Carabidae and Forficulidae were also observed in relatively high abundance. The presence of predatory insects indicates ecological regulation within the chili agroecosystem and may contribute to suppressing pest populations naturally. According to Lavelle et al. (2020), diverse soil fauna communities support ecosystem stability and improve ecological resilience in agricultural landscapes.

Diversity, Evenness, and Dominance of Soil Insect Communities

Ecological indices were calculated to evaluate community structure and environmental conditions of local chili cultivation areas.

Table 2. Diversity indices of soil insect communities in local chili cultivation areas of Tidore

Ecological Parameter	Value	Category
Species Richness (S)	8	Moderate
Shannon–Wiener Diversity Index (H′)	1.84	Moderate
Evenness Index (E)	0.88	High
Dominance Index (C)	0.22	Low

The Shannon–Wiener diversity index (H′ = 1.84) indicated a moderate diversity category. This result suggests that local chili agroecosystems in Tidore still support relatively stable soil insect communities with sufficient ecological interactions among taxa.

The evenness value (E = 0.88) showed high community uniformity, indicating that individuals were relatively well distributed among taxa and no single taxon excessively dominated the community. According to Magurran (2013), high evenness generally reflects greater ecological balance and environmental stability.

Meanwhile, the dominance index (C = 0.22) was categorized as low, indicating that community composition remained heterogeneous and ecological pressure was relatively limited. Odum and Barrett (2005) explained that lower dominance values commonly occur in ecosystems with more balanced resource utilization and broader ecological niches.

Ecological Interpretation of Soil Insect Diversity in Local Chili Agroecosystems

The observed diversity pattern demonstrates that local chili cultivation in Tidore provides suitable habitat conditions for soil insect communities. Habitat characteristics such as vegetation cover, organic matter availability, soil moisture, and cultivation practices influence community composition and ecological functions.

Decomposer insects recorded in this study may contribute to accelerating organic matter breakdown and nutrient cycling processes. Predatory insects potentially support biological regulation, whereas omnivorous groups increase ecological flexibility within agroecosystems.

These findings support previous studies showing that soil biodiversity can be used as an ecological indicator of agricultural sustainability (Wall et al., 2015). Agricultural systems that maintain diverse soil fauna communities tend to exhibit greater ecological stability and improved environmental quality.

Overall, the moderate diversity, high evenness, and low dominance values indicate that local chili cultivation areas in Tidore still maintain favorable ecological conditions for supporting soil insect communities and sustaining agroecosystem functions.

CONCLUSION

This study demonstrates that the application of seed coating materials influences rice seed viability and early establishment potential, indicating that seed enhancement strategies can contribute to improving initial crop performance. The observed differences among treatments suggest that biological and natural coating materials interact differently with seed physiological processes during germination and seedling development.

The findings answer the research objective by confirming that several seed coating treatments using *Trichoderma* and natural materials produced distinct responses in rice viability. The study also indicates that natural and biological coating materials may provide opportunities to develop more environmentally friendly approaches for seed management in rice cultivation systems. Rather than functioning solely as protective layers, seed coating treatments can serve as carriers of active compounds that support seed physiological activation during the early growth phase.

From a practical perspective, the results provide initial scientific evidence supporting the potential utilization of biological and natural-based seed coating technologies as alternative approaches for improving seed quality and crop establishment. Nevertheless, broader validation under field conditions and additional studies involving different formulations and application rates are necessary to strengthen recommendations for agricultural implementation and sustainable rice production.

The application of *Trichoderma* as a seed coating material showed a positive contribution to rice seed viability compared with untreated seeds. However, under the experimental conditions used in this study, *Trichoderma* did not produce the highest response among all tested treatments. These findings indicate that the effectiveness of seed coating materials depends on the viability parameter evaluated and suggest that *Trichoderma* remains a promising biological agent for seed enhancement strategies.

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