PESTS INTENSITY IN POTATO (*Solanum tuberosum*) AND FABA BEAN (*Vicia faba*) INTERCROPPING IN SALARAN, GETASAN DISTRICT, SEMARANG REGENCY

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**ABSTRACT**

Tropical regions face threats from pests, leading to significant losses in the global potato supply. Intercropping potatoes with faba beans is being explored to control pest infestations in tropical areas. This study aims to provide insights into pest dynamics and improve pest management strategies for sustainable potato cultivation. The research evaluates five cropping systems, each replicated across seven beds: potato monoculture, alternating growth of potatoes and faba beans at a 2:1 ratio, planting faba beans between the rows of potatoes at a 1:1 ratio, growing faba beans between two beds of potatoes, and cultivating solely faba beans. The study looked at various factors such as the type and intensity of pest attacks on potatoes. It found that planting faba beans alongside potatoes can help reduce aphid (Homoptera: Aphididae) and mirid bug (Hemiptera: Miridae) attacks, but may not affect grasshopper (Orthoptera: Acrididae and Pyrgomorphidae) attacks. The distance between potato beds and the population of faba bean plants can also influence pest interactions. Understanding these dynamics offers important information for sustainable pest management practices in intercropping systems.

**Keywords:** pest, intercropping, potato, faba bean, damage level
INTRODUCTION

Potato (*Solanum tuberosum* L.) is crucial for global nutrition, providing essential carbohydrates, proteins, and nutrients like amino acids, iron, and vitamin C (Asgar, 2013). Indonesia is renowned for its significant potato production; in 2019 alone, it harvested 1,271 tons of potatoes and imported an additional 132 tons. Projections indicate that by 2022 there will be a rise in production to about 1,420 tons with a reduced import of around 124 tons (BPS, 2022). Despite its importance, tropical countries face persistent threats from pests that significantly jeopardize global potato quantity and quality. Average yield losses can reach up to 16 percent, increasing even further to between 30-70 percent in minimally managed areas (Campos & Ortiz, 2020). While chemical pesticides are effective against these threats, this practice may impact human health.

Intercropping systems offer a promising solution for addressing pest-related challenges in tropical potato farming (Parhusip & Girsang, 2023; Karagatzides et al., 2021; Redin et al., 2021; Musa et al., 2012; Garrett et al., 2001). By simultaneously growing two or more different crops, this method has the potential to create barriers against pests and attract natural predators (Suryadi et al., 2017). Identifying the main pests impacting potato cultivation in tropical areas like Indonesia is essential due to specific ecological conditions (Islam & Islam, 2017; Garrett et al., 2001; Helenius, 1991). Faba bean plants have been recognized as beneficial intercrops in this context (Babec et al., 2021; Karagatzides et al., 2021; Coulter, 2020). Faba beans, as a type of legume, can fix nitrogen, and enhance soil fertility (Banjarnahor, 2016). However, their utilization in intercropping systems with potatoes has been limited due to concerns about pest attacks.

Identifying the primary pests associated with potato cultivation in tropical regions is crucial. The unique challenges presented by the tropical climate underscore the need for targeted pest management strategies that address these specific threats. Safeguarding crops from pest-related risks is of utmost importance, given the significant role of potato production in global food security. While farmers in tropical areas traditionally practice intercropping with potatoes and faba beans, previous research by Anui and Banjarnahor (2020) has primarily focused on soil-borne pathogens rather than conducting a comprehensive examination of pests. This study aims to fill this gap by identifying prevalent pests within the intercropping system of potatoes and faba beans and exploring how the presence of faba beans and chosen intercropping methods influence pest infestations on potato plants in tropical climates. Through our investigation, we aim to provide valuable insights that contribute to a deeper understanding of pest dynamics in tropical potato cultivation, leading to more sustainable and effective pest management strategies.

MATERIAL AND METHODS

The research was conducted at the end of the rainy season, in December 2021 until June 2022, at the Salaran Experimental Field, Faculty of Agriculture and Business, Satya Wacana Christian University, Wates Village, District of Getasan, Semarang Regency, Central Java.
Province. Experimental plot is located at the coordinate point - 7.37524 S, 110.42564 E with an altitude of 1207 meter above sea level (MASL), a daily average temperature of 29 °C, and the monthly rainfall in the study area was 42 – 427 mm.

**Cultivation Method of Intercropping Potatoes and Faba Beans**

The land was cleared, and solarization of the soil is carried out for approximately one week to reduce the attack of soil-borne pathogens in the form of fungi. Then, the beds were formed according to the treatment (see figure 1); each treatment had seven beds with a width of 30 cm and a length of 160 cm (five treatments and five replications). Then, the beds are covered with plastic mulch and given planting holes at a distance of 30 cm (each bed has five planting holes). Then, each planting hole is filled with the same amount of manure, 100 g/hole, and left for three days.

Potato seeds with visible sprouts on the tubers are placed in individual planting holes according to the prescribed method. Faba bean seeds, which need to be soaked in water and germinated first, are sown a week after the planted potato plants. The study area received faba bean seeds with emerging radicles per the designated treatment plan.

**Types of Pests on Potatoes and Faba Beans Intercropping**

Pest species were monitored weekly following the growth of potato plants (14 - 25 days after planting). Insects that caused disturbance to the plants were captured using a net, documented with a cell phone or digital camera, and then preserved in 70 percent alcohol for microscopic observation. After microscopic examination, the insects disrupting the plants were identified. The diseases affecting the plants were also monitored for symptoms and their progression every seven days, with efforts made to identify both symptoms and types of damage.

![Figure 1 Sketch of cropping pattern with intercropping: potato monoculture (P1); potatoes and faba beans are grown alternately 2 : 1 (P2); faba beans are planted between the potato beds 1 : 1 (P3); faba beans are planted between two potato beds (P4); and faba bean monoculture (P5). (Black squares are sample locations)](image-url)
Pest Attack Intensity

Percentage of attacks on plant data obtained from several plants selected in the middle beds. Observations on the extent of damage begin 14 days after planting and continue until 90 days after planting or the death of the plant. To determine the severity of damage caused by pests and diseases, a formula developed by Napitu et al. (2012) and Natawigena (1985) is used. The formula used to determine the intensity of damage caused by pests and diseases in the intercropping system of potato and faba bean is as follows:

\[ P = \frac{a}{a + b} \times 100\% \]

Information:
P = pest attack intensity (%)
a = the number of trees affected
b = the number of healthy trees

Percentage of Damage to Potato Plants

Observations were made on the level of damage caused by pests and diseases from 4 days after planting until either 90 days after planting or the death of the plant. The severity of pest infestations is assessed using a percentage computed based on a method described by Natawigena (1985). The formula used to determine the percentage of damage caused by pests and diseases in the intercropping system of potato and faba bean is as follows:

\[ I = \frac{\sum (n \times v)}{Z \times N} \times 100\% \]

Information:
I = percentage of damage (%)
n = number of plants with the same damage category
v = damage scale value for each attack category
Z = highest damage value
N = number of plants observed

The extent of harm is determined by various factors, including the plant’s physical condition and the type of attack. Please refer to the detailed table (Saputra & Aluyah, 2019) below to assess the damage level corresponding to each attack type.

RESULT AND DISCUSSION

1. Types of Pests in the Intercropping System

This research reveals a range of insect infestations affecting potato and faba bean crops. The study identified four specific types of insects that attack potato plants based on classification by order, while two target faba bean plants. Table 2 provides a detailed

<table>
<thead>
<tr>
<th>Degree of damage</th>
<th>Types of damage to plants</th>
<th>Score</th>
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<tbody>
<tr>
<td>Healthy</td>
<td>Leaves in good condition, stems in good condition (&lt;20%)</td>
<td>1</td>
</tr>
<tr>
<td>Light damage</td>
<td>Symptoms appear in the form of hollow leaves, spots appear on the leaves (21-40%)</td>
<td>2</td>
</tr>
<tr>
<td>Slightly heavy damage</td>
<td>Spots enlarge, spots appear on the stems, leaves begin to curl, dry with holes, leaves begin to wilt, stems slightly wither (41-60%)</td>
<td>3</td>
</tr>
<tr>
<td>Heavy damage</td>
<td>The leaves start to run out, the buds start to break down, the stems turn yellow and wither or rot, the leaves start to disappear (61-80%)</td>
<td>4</td>
</tr>
<tr>
<td>Very heavy damage</td>
<td>Severely damaged or dead (81-100%)</td>
<td>5</td>
</tr>
</tbody>
</table>

Tabel 1 Scoring the level of damage in plant
breakdown, showing that four insect families exclusively target potato plants, one solely attacks faba bean plants, and four families show a mixed propensity by attacking both samples. This intricate categorization enhances our understanding of the complex dynamics within insect-plant interactions related to the studied crops.

**Cocci beetles larvae (Coleoptera: Coccinellidae)**

The larvae that damage potato plants have unique traits compared to Coccinellidae, which are their predators. The damaging larvae can be recognized by spines on their backs, needle-like projections, and a generally oval body shape. In contrast, the predatory Coccinellidae larvae have longer bodies with shorter unbranched spines (Senewe, 2019; Waskito et al., 2018; Kahono, 2010; Patimatuzzohrah & Haryanto, 2018). The larvae of the cocci beetle have chewing mouthparts that result in distinct symptoms on affected plants, such as perforations on leaves. These visible manifestations of pest infestation are easily recognizable and cause holes in the leaves, forming distinctive patterns resembling stripes. Making these specific observations provides valuable insights into the impact of insect activity on potato plant health and helps understand their behavior more thoroughly.

**Chrysomelidae beetles (Coleoptera: Chrysomelidae)**

Belonging to the Coleoptera order, Chrysomelidae beetles are known for their distinctive characteristics that set them apart within insect diversity. They can be identified by their sturdy, intricate, and dark exoskeletons and possess a small body size, measuring only 1.5 mm (Hiiesaar et al., 2020; Segers et al., 2022). Chrysomelidae is renowned for its distinctive large femurs on their hind legs, which are reminiscent of the sturdy hind limbs found in grasshoppers. As detailed by Nurkhalifah et al. (2022), the larger femurs are essential for the beetle’s mobility, allowing it to maneuver through its surroundings by combining jumping and flying.

The complex relationship between Chrysomelidae and the plants they inhabit becomes apparent when observing the consequences of their presence (Izzo et al., 2018; Schoville et al., 2018). Infested plants often display characteristic signs of injury, with small irregularly-shaped holes spread across the leaves. The distinct pattern of damage is caused by the unique
chewing mouthparts of these beetles. This highlights the complex and symbiotic relationship between Chrysomelidae beetles and their plant hosts, enriching our understanding of insect ecology and emphasizing the importance of thorough observation in uncovering pest-induced damage mechanisms in plant ecosystems.

**Aphids (Homoptera: Aphididae)**

These insects belong to the Homoptera category, specifically within the Aphididae family. As part of this family, aphids have a small body size of about 0.5 mm and a rounded, slightly oval shape. A distinctive feature of aphids is their specialized mouthparts called a stiletto, which they use for sucking and piercing. The observed aphids in this research were in the nymph stage, characterized by the absence of wings as described by Yoshizawa & Lienhard, 2016; Nuessly et al., 2009; Triplehorn et al., 2005. On the other hand, the imago stage is characterized by the presence of wings.

Table 2 presents a categorization of pest types, highlighting the presence of two different aphid species. The study demonstrates that aphids commonly attack various parts of plants, such as the leaves and apical shoots of both potatoes and faba beans. However, Aphid 2 displays a more selective behavior by exclusively infesting faba bean plants and establishing colonies on their shoots. The impact of aphid infestation becomes apparent through the physical damage to plant leaves, which is characterized by curling and drying out. This observation supports the findings of Bennour et al. (2021) and Lrsan et al. (1998), who attribute these symptoms to aphids extracting fluids from plant leaves through their feeding activities.
Further categorization based on body color, host plant, and geographic distribution reveals that aphid 1 belongs to the *Myzus persicae* species (Sternorrhyncha: Aphididae), while aphid 2 is classified as part of the *Aphis fabae* species (Martin & Brown, 2008; Blackman, 2006). These taxonomic details enhance our understanding of the specific aphid species involved in the observed interactions with potato and faba bean plants.

**Mirid Bugs (Hemiptera: Miridae)**

Mirid insects, part of the Hemiptera order, play a significant role in the complex ecosystems within plant environments. The mirid bugs observed in this research belong to the Miridae family and are known for a distinguishing feature called a cuneus. According to Triplehorn et al. (2005), members of the Miridae family possess a cenus, which is a triangular shape on their forewings located near the membrane and containing two venous cells. These insects typically measure between 7-10 mm and have distinct black bodies with an orange-brown thorax that helps them blend into different plant backgrounds where they reside.

Mirid insects use tiny mouthparts to pierce and extract fluids from plant shoots. This feeding behavior, highlighted by Antwi & Rondon (2019) and Haye et al. (2006), is particularly important as they target developing faba bean flowers. Although the damage caused by mirid bugs may not be immediately obvious due to the subtle nature of their feeding marks, understanding their behavior in detail significantly contributes to comprehending their impact on plant ecosystems and helps in developing efficient pest control strategies.

**Grasshoppers (Orthoptera: Acrididae and Pyrgomorphidae)**

Grasshoppers, the primary insect species under investigation, hold a position of ecological importance due to their distinct characteristics. Categorized as part of the Orthoptera order, these insects are known for their significant body size that varies between 2 and 3 cm and display an interesting combination of green and brown colors. Notably, their hind limbs are characterized by large femurs, which is a structural adaptation that enhances their ability to jump and fly (Rahayu et al., 2021; Zeni et al., 2021). With chewing and biting mouthparts at their disposal, grasshoppers effectively demonstrate their impact on plants by creating noticeable holes along the edges of leaves - a distinctive signature of their feeding behavior when compared to other pests examined in this study.

Upon conducting further taxonomic analysis, it was determined that the grasshoppers observed in this research belong to the Acrididae family, specifically Pyrgomorphidae. These particular grasshoppers have a vivid green body hue, measure 2-3 cm in length, and feature a conical thorax with brief antennae. A notable characteristic of this group is the faint but noticeable purple design on their hind wings that becomes apparent during flight an aspect that enhances their aesthetic appeal.

Grasshoppers belonging to the Acrididae family, on the other hand, exhibited a more understated brown coloration and had a comparable body size ranging from 2-3 cm (Patimatuzzohrah & Haryanto, 2018; Kessek et al., 2015; Tan & Kamaruddin, 2014). Their distinguishing features from Pyrgomorphidae
counterparts included a non-tapered thorax and short antennae. Triplehorn et al. (2005) further emphasized the uniqueness of the Acrididae family by highlighting the backward tilt of their thorax when observed from the side. These intricate morphological and behavioral differences among grasshopper families contribute to their taxonomic diversity and provide insights into their diverse ecological roles and impacts within various ecosystems.

**Caterpillars (Lepidoptera: Pyralidae and Geometridae)**

In the intricate web of this research’s ecosystem, the bean plants experienced complex relationships with caterpillars belonging to the Lepidoptera order. This revealed a diverse range of caterpillar species, each making a unique impact on faba beans. The observed caterpillars, ranging from 3 to 5 cm in size, displayed an intriguing way of moving using their prolegs. It is worth noting that they migrated between plants infrequently, highlighting the specificity of their interactions. These Lepidoptera larvae had chewing mouthparts and carefully nibbled on plant leaves, leaving distinct holes behind. Furthermore, these interactions were found to have significant implications for both the bean plants and the caterpillars involved.

One species of caterpillar stood out in the group due to its noticeable impact—faba bean leaves elegantly curling in response to its feeding activities. This particular caterpillar has a vibrant green color, measures 2.5 cm in body size, and features an eye-catching black head, matching the characteristics of the legume leaf roller caterpillar. The identification was based on field observations and symptomatic analysis as documented in various studies (Brockerhoff et al., 2011; Nuessly et al., 2009; Redin et al., 2021; Triplehorn et al., 2005). Additional research into its taxonomic classification by Daud et al. (2020) and Kessek et al. (2015) confirms that this caterpillar belongs to the Pyralidae family, solidifying its place within insect taxonomy’s complex network.

Another intriguing type of caterpillar has revealed its distinct characteristics on faba bean plants. It features false feet at both ends of its body and moves in a unique way, resembling someone measuring with a hand span, which has led to it being called the “span caterpillar.” According to Sutrisno (2015), this species belongs to the Geometridae family in terms of taxonomy. These detailed observations enhance our understanding of the intricate interaction between caterpillars and faba bean plants and highlight the crucial significance of precise identification for developing targeted and efficient pest control methods.

### 2. Pest Attack Intensity on Intercropping of Potatoes and Faba Beans

The study’s results in Table 3 reveal a variety of attacks on the cultivated plants, highlighting the complex dynamics of insect-plant interactions. An intriguing finding is that while some insects targeted only one type of plant, others had a diverse diet and attacked both Rahayu et al. (2021) and Zeni et al. (2021). This variation in attack behavior can be attributed to the intricate interplay between insect food preferences and specific inherent factors.

In this study, grasshoppers, mirid bugs, and aphids proved to be highly adaptable attackers,
Pests Intensity In Potato (*Solanum tuberosum*) and Faba Bean (*Vicia faba*) Intercropping in Salaran, Getasan District, Semarang Regency | Andree Wijaya Setiawan et al.

Targeting potato and faba bean plants. Their assaults resulted in distinct markings on the leaves, particularly evident as non-uniform damage along the edges. This demonstrates their specific feeding behaviors. Regarding quantity (refer to Table 3), grasshoppers emerged as significant culprits with the highest level of attacks compared to other insects. The increased intensity of grasshopper attacks can be attributed to several factors such as their high population density within the field. Furthermore, the expansive nature of the research area surrounded by diverse grassy vegetation and adjacent agricultural plots provides an ideal habitat for grasshoppers. This finding is supported by Falahudin et al. (2015) findings which emphasize how common grasshoppers are to thrive across various vegetative landscapes due to their indiscriminate feeding habits across different plant types. This comprehensive understanding of attack dynamics contributes significantly towards our comprehension of insect behavior while highlighting complex ecological factors influencing these interactions within agricultural settings.

Aphids and mirid bugs are commonly found on potato and faba bean plants because they can feed on a wide range of hosts. While grasshoppers do not show a strong preference for faba beans, mirid bugs and aphids tend to favor these plants during the generative phase when they are most vulnerable. Research by Martorana et al. (2017) and Nuessly et al. (2009) has revealed that numerous mirid bugs gather on faba bean flowers during this critical phase. Faba beans, being herbaceous plants with piercing-sucking mouthparts, are particularly attractive to insects in this category as their compound flowers provide an ideal feeding and breeding ground for them.

Certain insects specialize in attacking specific crops. For example, the Coleoptera order exclusively targets potatoes, while caterpillars and aphids singularly afflict faba beans. The study observed that cocci beetles exclusively target potato plants, causing characteristic damage to leaf veins. Research from Kahono (2010) has also shown that these beetles are less active in searching for food and instead show heightened activity on host plants of the Solanaceae family. They consume and reproduce on potato plants. Larvae of cocci beetles cause significant damage to potato plant leaves, with an attack intensity reaching 40 percent in the potato monoculture treatment as detailed Table 3.

In contrast to round beetles, the Chrysomelidae were observed exclusively attacking specific

<table>
<thead>
<tr>
<th>Tabel 3 Pest Attack Intensity on each multiple cropping pattern</th>
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<tr>
<td><strong>Type of Pest</strong></td>
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<td>------------------</td>
</tr>
<tr>
<td>Cocci beetles</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Chrysomelidae beetles</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Aphid 1</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Aphid 2</td>
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<tr>
<td></td>
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<tr>
<td>Mirid bugs</td>
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<tr>
<td>Acrididae &amp; Phyrgomorphidae</td>
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<tr>
<td></td>
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<tr>
<td>Geomitrinidae &amp; Pyralidae</td>
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Description: P means potato, and FB means faba bean. (P1); potatoes and faba beans are grown alternately (P2); faba beans are planted between the potato beds (P3); faba beans are planted between two potato beds (P4); and faba bean monoculture (P5).
potato plant treatments at the edge of the study area. This resulted in characteristic symptoms of small holes on the leaf surface. Nurkhalifah et al. (2022) generally classify this beetle as a pest of mustard and cucumber plants; however, Campos and Ortiz (2020) propose that this pest can cross boundaries and threaten potato plants in different regions. The proximity of the research area to former mustard greens and cucumber fields provides a plausible explanation for this observation since these pests may migrate and target potato plants when their main food sources are exhausted. This complex ecological interaction between insects and crops reveals a story of adaptation within agricultural environments.

Caterpillars and aphids pose the primary threat to faba bean plants. Aphid colonies have a tendency to gather on the flowering shoots of these plants, choosing them based on specific food preferences and suitability for breeding. According to studies by Nuessly et al. (2009) and Martin & Brown (2008), these pests particularly favor young leaf shoots as an optimal location for reproduction. Moreover, research by Martorana et al. (2017) and Nuessly et al. (2009) emphasizes that the attractiveness of faba bean plant flowers significantly contributes to drawing these pests in forming colonies.

Caterpillars, the larvae of lepidopteran insects, specifically targeted faba bean plants in this research, with relatively limited attacks. This pattern could be explained by the preference of adult Lepidoptera for faba beans as hosts for their larvae after hatching. Field observations have also documented various types of caterpillars attacking faba beans. The life cycle of Lepidoptera involves laying eggs on plants, which then hatch and continue through their life cycle according to Brockerhoff et al. (2011). They selectively opt for suitable plants for egg-laying and subsequent larval development post-hatching.

3. Level of Damage Due to Pests on Potato Plants

The detailed examination of two outcome tables, Table 3 and Table 4, uncovers a complex relationship between the variables at play. The degree of damage seen in different treatments of potato plants during the study is closely tied to the severity of pest attacks in each treatment (Figure 3). This correlation is particularly pronounced in treatments with high pest attack intensity, leading to elevated levels of inflicted damage. Among the insect adversaries, grasshoppers stand out as significant challengers, exhibiting robust attack intensities of 60 percent and 69 percent on potato plants P1 and P3 respectively. Notably, these grasshoppers substantially impacted these treatments by causing the highest recorded damage level at 38 percent. Further analysis reveals that cocci beetles unleash their most forceful assault in P1 with an attack intensity reaching 42 percent, resulting in considerable damage at a rate of 32 percent for this treatment. This intricate interplay between pest attack intensity and resulting damage underscores the importance of delving into specific details about pests’ dynamics to develop effective and targeted crop management strategies. As we unravel these complexities further, it becomes increasingly apparent that having a comprehensive
understanding of how pests interact with crops is essential for promoting resilient and sustainable agricultural practices.

The severity of pest infestations is widely acknowledged to be linked to the resulting extent of harm, as stated by Jiménez and Valenzuela-Celis (2022). This assertion aligns with the findings of this research: treatments with high levels of pest infestation also showed increased levels of damage. The substantial population of pests within each treatment can be attributed to this association, a factor that was limited by the method employed in describing population dynamics in this study. Kaparang et al. (2011) provides additional support for this understanding, emphasizing that the extent of damage depends heavily on two key factors: the population of pests and their inherent destructive capability. Throughout this study, grasshopper pests and herbivore beetles are identified as perpetrators capable of causing harm to leaves, leaving distinct marks that serve as tangible evidence of their relentless attacks. The concurrence among these insights highlights how various factors such as population dynamics and intrinsic destructive potential exhibited by involved pests influence pest-induced damage.

Insects belonging to the Hemiptera order have a significant impact, causing less overall damage due to their unique feeding method of delicately piercing plant parts with their small mouthparts. Previous study explores the behavior of pests with a sucking-piercing mouth structure and reveals that physical damage is more likely at very high levels of attack intensity. Surprisingly, at low attack intensities, these seemingly harmless pests can still pose a hidden threat by potentially transmitting viruses.

![Figure 3](image)

Figure 3 Visualization of (a) damage due to cocci larvae, (b) damage due to green aphid, (c) damage due to cocci beetle, (d) damage due to grasshoppers.

<table>
<thead>
<tr>
<th>Type of Pest</th>
<th>Degree of Damage (%)</th>
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<tbody>
<tr>
<td></td>
<td>P1</td>
</tr>
<tr>
<td>Cocci beetles</td>
<td>32</td>
</tr>
<tr>
<td>Chrysomelidae beetles</td>
<td>23</td>
</tr>
<tr>
<td>Mirid bugs</td>
<td>36</td>
</tr>
<tr>
<td>Aphid 1</td>
<td>27</td>
</tr>
<tr>
<td>Acrididae &amp; Phyromorphidae</td>
<td>38</td>
</tr>
<tr>
<td>Geomitridae &amp; Pyralidae</td>
<td>20</td>
</tr>
</tbody>
</table>
This complex relationship between attack intensity and the risk of viral transmission highlights the crucial necessity for understanding pest behavior when developing effective management strategies. As low-intensity attacks by Hemiptera may carry disproportionate risks, comprehensive approaches are needed to mitigate both direct damage and the indirect danger of virus spread. This realization emphasizes the importance of an all-encompassing and knowledgeable approach to pest management that takes into account immediate harm as well as potential latent threats posed by certain pests.

4. Effect of Intercropping of Potato and Faba Bean Crops

The thorough analysis of the study’s observations indicates that intercropping faba bean plants with potatoes has a significant impact on pest attacks, as revealed in Table 3. It is evident that potato plants experienced significantly lower pest attacks from the Hemiptera order compared to faba bean plants. This complex relationship may be due to the attractiveness of faba bean plants to insects, especially those with piercing-sucking mouthparts. Faba beans, particularly during their reproductive phase, are attractive to insects belonging to the Hemiptera order and exhibit a special affinity for compound plant flowers (Martorana et al., 2017; Nuessly et al., 2009).

Furthermore, the arrangement of potatoes and faba beans in intercropping systems plays a crucial role in determining pest attack intensity. As indicated in Table 4 data, the P3 intercropping approach—simultaneous cultivation of both crops—results in increased grasshopper attacks on potato plants due to higher plant population attracting more pests. In contrast, scenarios P2 and P4 with lower plant populations and wider spacing between them lead to reduced grasshopper attraction. The distinct shape of tall faba plants serves as a natural barrier against migratory pests like grasshoppers when compared to low-lying potato plants’. Additionally, different spacing influences micro-humidity and temperature levels which create conditions favorable for specific pest habitats (Warsito et al., 2021). These findings underscore the intricate connections between crop arrangement strategies, plant characteristics, and environmental factors influencing pest dynamics within intercropping systems.

CONCLUSION

Incorporating faba bean plants alongside potatoes is a strategic choice that can help reduce the intensity of attacks and associated damages by aphids and mirid bugs. Among the various intercropping methods studied, planting faba beans between potato beds effectively mitigates aphid and ladybug attacks but does not reduce grasshopper attack. However, high plant population and constrained spacing of faba beans between potato beds may attract grasshoppers, exacerbating their attacks. On the other hand, planting faba beans between two potato beds effectively suppresses attacks by coccid beetles. This nuanced understanding of pest dynamics within intercropping systems provides valuable insights for optimizing sustainable and integrated pest management practices.

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