# AGROECOYSTEM ENGINEERING THE USE OF REFUGIA PLANTS IN MANAGING PEST POPULATIONS OF ONION PLANTS (Allium ascalonicum L.)

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**Abstract**

Shallots (Allium ascalonicum L.) is one of the horticultural commodities that has an important role in the Indonesian economy. One of the main threats to this plant is the attack ofthe pest Spodoptera exiguawhich can cause significant damage, especially at heavy infestation rates resulting in leaves drying out and falling prematurely. In an effort to control the population of this pest, one planting pattern system that can be usedThe intercropping system uses refugia plants such as marigold flowers (Tagetes erecta L.) and zinnia (Zinnia elegans), which act as shelters for natural enemies of pests, including predators and parasitoids. This study aims to evaluate the ability of refugia plants in controlling pest attacks on intercropped onion plants. The results showed thatat the observation of Week 1 no intensity of attacks occurred. In weeks 2, 3, 4, and 5 there were attacks with the highest attack intensity was 1.25% in P0 treatment and the lowest attack intensity in P2 treatment.Meanwhile,P1 and P2 treatment showed lower pest population densities compared to P0.P0 treatment shows the highest pest population density compared to other treatments. In addition, arthropod diversity analysis resultedan index of 2.07%,indicating the level of species diversity that is in the refugia intercropping system.Because the percentage of attacks of such treatment ranges from>0-≤10%.

Keywords **:** ***Refugia; T. erecta L; Zinnia elegans; S. Exigua***

## 1. INTRODUCTION

Shallots (Allium ascalonicum L.) are one of the useful horticultural commodities in Indonesia. Shallot production in Indonesia reaches 2 million tons per year, but actual production has only reached 1.5 million tons per year. One aspect that is an obstacle to increasing shallot production is pest attacks (BPS, 2023). Efficient pest control has become highly desirable. In controlling pests and diseases of shallot plants, it cannot be separated from the use of pesticides. Continuous use of pesticides on plants can result in high production costs and can have a negative impact on the environment and the health of living creatures (Nuryulsen and Safridar, 2019). The main pest of shallots is Spodoptera exigua, which can cause significant damage.Heavy insects cause the leaves to dry out and fall prematurely so that the quality and quantity of shallots decreases. This pest attack can cause yield losses of up to 100% (Marsadi et al., 2017).Armyworms can attack all parts of the shallot plant, from the leaves, stems, to the bulbs. The use of pesticides is one of the most common methods of controlling armyworm pests. However, excessive use of pesticides can have negative impacts on the environment and human health. Therefore, a more environmentally friendly and sustainable pest control strategy is needed (Mulyani et al, 2016). Planting refugia on cultivated plants aims to reduce the use of synthetic pesticides, increase production, and maintain ecosystem balance. Refugia can be used as a shelter for natural enemies of pests in cultivated plants such as predators and parasitoids (Keppel, et al, 2012).Refugia plants are flowering plants which provide a habitat for insects because they are able to provide the food that insects need in the form of nectar and honey.

The presence of natural enemies can be increased by providing habitat and food sources for their survival so that refugia around plantations become alternative habitat for predators and parasitoids (Sumini and Bahri 2020). Refugia can be colored flowering plants that support

conservation activities as an option for maintaining agroecosystems on agricultural land (Allifah et al. 2013).The existence of these natural enemies must be maintained in an effort to prevent pest outbreaks, one of which is by planting flowering plants around the plants. One of the planting pattern systems that can be chosen is the intercropping system for shallot plants. Using the tumpeng sari planting pattern can increase insect diversity and keep the agricultural ecosystem stable. One of the refugia plants used is marigold flowers and zinnia flowers. Marigold flowers (Tagetes erecta L.) are compound flowering plants belonging to the Asteraceae family or kenikir-kenikiran with the genus Tagetes. Tagetes is used as a cone plant and also as a biological control plant. The benefits of Tagetes include protection against nematodes that harm plants, insect repellent, antibacterial and anti-fungal properties (Sobir, R, et al, 2017). Tagetes is a plant that is favored by parasitoids and plant pest predators. Nectar and pollen from Tagetes can increase the fecundity of parasitoids and predators, so that their populations increase. This can increase the potential of Tagetes as a natural controller of plant pests. Zinnia flowers (Zinnia Elegans) are a type of plant that can provide shelter, food sources and other resources for natural enemies from predators and parasitoids, so they can be used as refugia (Widia, 2019). According to Novrianti (2017), Z. elegans refugia can attract natural enemy insects because these flowers have varying colors from paper flowers, including red, pink, white, blue and orange. In addition, the paper flower plant (Z. elegans) contains active compounds of flavonoids, glycosides, tannins, anthocyanins, saponins and phenols (Asmaa et al, 2015).

## 2. IMPLEMENTATION METHOD

### Time and place

This research will be carried out in Sampe Cita Village, Kutalimbaru District, Deli Serdang Regency, North Sumatra Province, with an altitude of M above sea level. This research was carried out from October 2023 to February 2024.±500

### Tools and materials

The materials used are shallot seeds of the Bima Brebes variety, cow compost, refugia marigold flower seeds and refugia zinnia flower seeds. The tools used are a hoe, gembor, sweep net, measuring tape, wood, camera, stationery, microscope and identification book.

### Research methods

This study used a non-factorial randomized block design (RAK) with 4 treatments and 6 replications, namely: P0: Without refugia plants (Control), P1: Shallot plants intercropped with marigolds, P2: Shallot plants intercropped with zinnias, P3: Onion plants are intercropped with marigolds and zinnias. So there were 4 treatments with 6 replications, so there were 24 experimental units and each experimental unit contained 4 plants so that the total number of plants was 96 plants.

### Research Implementation

Preparation of Shallot Seeds

Propagation of shallots is done using bulbs as shallot seeds. The criteria for good bulbs for shallot seeds must come from plants that are quite old, namely 70-80 days after planting, with a size of 5-10 grams, a diameter of 1.5-1.8 cm. At the tip of the shallot seed tuber, cut about 1/5 of the length of the bulb to accelerate shoot growth.

Land Management

The research land area has a height of ±500 m above the sea level (DPL). Land processing also aims to create the shape, number and distance between plots. The distance between plots on

the land is 25 cm, the height of the plots used is 30 cm, and the width of each plot is 60cm x 60cm. In land processing, the planting medium used as a mixed medium is cow dung compost, to add nutrients from cow dung.

Planting

Before planting, the plot of land is watered sufficiently so that the topsoil is sufficiently moist. After it dries a little, the lines are made parallel to the width of the plot and 2-3 cm deep. The planting distance used is 20cm x 20cm. The seeds are immersed in the guritan in an upright position and slightly pressed down, then covered with a thin layer of soil. The planting distance between the main plant and the refugia is 20 cm with a depth of 5-10 cm. The number of shallot plants per plot is 4 plants.

Maintenance Sprinkling

Watering is carried out in the morning and evening using a gembor. If it rains in the morning then only in the afternoon it is watered, if it rains in the morning and evening or throughout the day then there is no watering.

Fertilization

Basic fertilizer consists of applying cow dung compost before planting or when tilling the soil, then apply itchemical fertilizer in the form of NPK fertilizer (15:15:15) is given according to a predetermined dose with the fertilizer application technique carried out in stages in accordance with the Shallot Pro League Technical Technical Guidelines (Suwandi, et al., 2016).

Weed Control

This is done every 7 days manually by pulling out weeds that grow and hoeing, so that there is no competition with the main plant.

Planting Refugia Plant Seeds

Refugia plants are planted in seed form. The refugia plants chosen were marigold and zinnia flowers. Refugia transplantation was carried out at 21 HST. Refugia plants are planted at a spacing of 20 cm, alternating marigold and zinnia flowers.

## 3. RESULTS AND DISCUSSION

Pest Attack Intensity

The intensity of pest attacks was calculated by observing the percentage of leaf damage based on the plant leaf damage score on plant samples diagonally in each experimental plot. The intensity of pest attacks is calculated using the formula according to Masauna, et al (2013) as follows:

$$IP = (ni \times vi / (Z \times N) \times 100\%$$

Information:

IP :intensity of attack/plant damage (%)
here :number of plants or sample plant parts with the scale of damage
vi : damage scale value for example i
N :number of sample plants
Z :highest damage scale value

After the intensity of the S. exigua pest attack can be calculated based on the percentage of attacked plants, it will be entered into the attack criteria table (Table 1) to determine the level of S. exigua pest attack in each treatment.

Table 1.Attack RateS. exiguaon shallot plants

| No | Attack Percentage | Attack Rate |
|---|---|---|
| 1 | 0% | Healthy |
| 2 | >0-≤10% | Very low |
| 3 | >10-≤20% | Low |
| 4 | >20-≤40% | Currently |
| 5 | >40-≤60% | Tall |
| 6 | >60-≤100% | Very high |

Source: Ngawit et al., 2023

Table 2. Table of Presentation of Attack Intensity

Presentation Table

Attack Intensity (%)

| Treatment | M1 | M2 | M3 | M4 | M5 | Total | Average |
|---|---|---|---|---|---|---|---|
| P0 | 0a | 0.31a | 0.31a | 0.31a | 0.31a | 1.25 | 0.25 |
| P1 | 0a | 0a | 0.31a | 0a | 0.31a | 0.63 | 0.13 |
| P2 | 0a | 0.31a | 0a | 0a | 0a | 0.31 | 0.06 |
| P3 | 0a | 0a | 0a | 0.31a | 0.31a | 0.63 | 0.13 |

Information:Numbers followed by the same letter indicate that they are not significantly different in the 5% Duncan test

Based on the results of observing the intensity of attacks in the table, it shows that the intensity of pest attacks has no real effect on shallot plants. During the 1st week of observation, there was no intensity of attacks occurring. In Week 1, pest attacks on shallots had not yet occurred because the shallot plants were still in the growth and bulb formation stage. Shallot plants need quite a lot of water during growth and bulb formation, especially during the dry season. Caterpillars, which are the main pest of shallots, bore into the leaves and enter them, damaging the inner leaf tissue, causing the leaves to dry out. Caterpillar attacks usually occur in the dry season. However, in Week 1, the shallot plants were still in the growth stage and had not yet reached the effective phase for pest attacks (DTPH, 2023). At Weeks 2, 3, 4 and 5, attacks appeared with the highest attack intensity being 1.25% in treatment P0. Increased attacksS. exiguaapart from the treatment factor, it is also closely related to the increasing age of the shallot plants. Because according to Moekasanet al. (2012), the older the shallot plant, the thicker the leaves grow, as a result, the more shallot leaves are attacked.S. exigua. The intensity of pest attacks in treatments P0, P1 and P3 showed no significant differences between these treatments. This condition shows that the three treatments are not effective in suppressing pest populations and providing a level of protection for plantsA. ascalonicumL. Meanwhile, treatment P2 (Zinnia) showed the lowest pest attack intensity of 0.31%, which shows that pests on shallot plants can be controlled by this treatment. This matterBased on indicators and criteria for the level of S. exigua attack on onion plants, Moekasan et al. (2012), stated that the intensity of attacks on treatments without refugia and shallot plants with refugia were included in the criteria for a very low level of attack. Kbecause the percentage of attacks for these treatments ranges between>0-≤10%.

Population density

To calculate the population density of the pest S. exigua, use the formula (Paparang, 2016).

Kepadatan Populasi=n/N

Information:

P= Population

n=Number of S. exigua in each sample

N=Number of plant/plot sample populations

Table 3. Average population density

**SERVING TABLE**

**TABLE OF AVERAGE POLULATION DENSITY BASED ON PLANTS AND OBSERVATION TIME**

| TREATMENT | PLANT | AVERAGE POPULATION DENSITY OF S. Exigua | | | | |
|---|---|---|---|---|---|---|
| | | WEEK 1 | WEEK 2 | WEEK 3 | WEEK 4 | WEEK 5 |
| P0 | 1 | 1.11a | 3.05ab | 3.89abc | 0.17 BC | 0.50 c |
| | 2 | -5.55a | 2.78ab | 0.17 abc | -1.67 bc | 0.67 c |
| | 3 | 0.00 a | 2.78ab | 5.55abc | 0.00 bc | 0.17 c |
| | 4 | -5.55a | 0.17ab | 0.17 abc | -1.33 bc | 0.33 c |
| P1 | 1 | 6.94ag | 1.39abgh | 4.28abcghi | 8.33 bchi | 0.17 ci |
| | 2 | -1.01ag | 9.65abgh | 1.44abcghi | -2.90 bchi | 1.38 ci |
| | 3 | -4.03ag | -8.33abgh | 0.17 abcghi | 0.33 bchi | 0.17 ci |
| | 4 | 3.64 aug | 1.08abgh | 6.94 abcghi | -1.06bchi | 5.38 ci |
| P2 | 1 | -3.64dj | 4.16 dejk | 5.90 defjkl | 1.27 efkl | 1.46 fl |
| | 2 | -2.10dj | 2.38dej | 3.80defjkl | -2.22 efkl | 1.58 fl |
| | 3 | 1.20dj | -1.01dejk | 3.90 defjkl | 2.00 efkl | 1.02 fl |
| | 4 | -4.97dj | -2.85dejk | 5.17 defjkl | -2.31 efkl | 7.57 fl |
| P3 | 1 | -1.06gj | 1.04ghjk | 1.35 ghijkl | 0.17 hicl | -2.43 ill |
| | 2 | 2.41gj | 1.54ghjk | 1.81 ghijkl | 1.03 hicl | 4.00 ill |
| | 3 | -8.59gj | 1.85ghjk | 6.29 ghijkl | -1.02 hicl | -2.07 ill |
| | 4 | 6.01gj | 6.67ghjk | -3.78 ghijkl | 4.78 hicl | -4.68 ill |

Note: Numbers followed by different letter notations indicate that they are significantly different in the Mann-Whitney test with a significance level of $\alpha = 5\%$

Based on the results of the population density test, the results showed that there was a significant difference in the average population density of S. exigua between treatments P0, P1, and P2. Treatment P0 (control) showed the highest pest population density in almost all plant varieties and observation times. This shows that the S. exigua population is growing rapidly without any control efforts. This shows that without control efforts, the S. exigua population can grow rapidly and cause significant damage to shallot plants. Treatments P1(marigold) and P2(zinnia) showed lower pest population densities compared to P0(control). Treatment P2 (zinnia) plant 4 showed the most optimal results in suppressing the S. exigua population, with the lowest average pest density for several plant varieties and observation times. Zinnia refugia flowers are effective in controlling S. exigua because of their effect on natural enemy insects which are predators and parasitoids of S. exigua. Zinnia refugia flowers have very diverse colors, which are very attractive to natural enemy insects, so they can become hosts for orthopteran pests (Pratiwi, Y. et al, 2022). Arthropod Diversity Observations were also made on diversityThis was done by catching insects in the treatment plot using a sweep net. The captured arthropods are then identified to family level and grouped based on their role in the agroecosystem. Species diversity was obtained using the Shannon-Wiener diversity index formula, in Soedijo and Pramudi (2015):

H' = -∑ pi ln(pi)
Information:
H' = Shannon-Wiener diversity index
pi = Proportion of individuals in species i (ni/N)
ln = Total number of individuals of the species
Diversity categories are determined based on the rules according to Heriza (2016) as follows:
H< 1 = Low diversity
< 1H< 3 = Medium diversity
H > 3 = High diversity

Table 4. Identification of arthropods in refugia plants

| Types of Arthropods | Family | Order | Number of Individuals | Role |
|---|---|---|---|---|
| *Dissosteira*(Grasshopper) | *Acrididae* | *Orthoptera* | 21 | predator |
| *Orthetrum sabina*(Green Dragonfly) | *Thripidae* | *Odonata* | 6 | predator |
| *Gryllidae*(Cricket) | *Gryllidae* | *Orthoptera* | 7 | pest |
| *atherigona sp*(Seed Flies) | *Muscidae* | *Diptera* | 10 | pest |
| *Oxyopidae*(Spider) | *Oxyopidae* | *Araneae* | 11 | predator |
| *Neotoxoptera formosana*(Leek Aphid) | *Aphidae* | *Hemiptera* | 23 | pest |
| *Spodoptera litura*(Armyworm) | *Noctuidae* | *lepidoptera* | 7 | pest |
| *Napomyza lateralis*(Leaf Fly) | *Agromyzidae* | *Diptera* | 9 | pest |
| *Coccinellidae*(Koksi Beetle) | *Coccinellidae* | *Coleoptera* | 7 | predator |

Table 5: Arthropod diversity percentage results using the Shannon-Wiener diversity index formula

| **Types of Arthropods** | **Number of Individuals** | **Pi=(ni/N)** | **LnPi** | **Pi. LnPi** |
|---|---|---|---|---|
| *Dissosteira*(Grasshopper) | 21 | 0.207921 | -1.5706 | -0.32656 |
| *Orthetrum sabina*(Green Dragonfly) | 6 | 0.059406 | -2.82336 | -0.1677244 |
| *Gryllidae*(Cricket) | 7 | 0.069307 | -2.66921 | -0.1849948 |
| *atherigona sp*(Seed Flies) | 10 | 0.09901 | -2.31254 | -0.2289639 |
| *Oxyopidae*(Spider) | 11 | 0.108911 | -2.21723 | -0.24148 |
| *Neotoxoptera formosana*(Leek Aphid) | 23 | 0.227723 | -1.47963 | -0.3369446 |

| | | | | |
|---|---|---|---|---|
| *Spodoptera litura*(Armyworm) | 7 | 0.069307 | -2.66921 | -0.1849948 |
| *Napomyza lateralis*(Leaf Fly) | 9 | 0.089109 | -2.4179 | -0.2154561 |
| *Coccinellidae*(Koksi Beetle) | 7 | 0.069307 | -2.66921 | -0.1849948 |
| Total | 101 | | | 2.07 |

Based on the results of observations, it shows that there were 9 species of arthropods found in the form of predators or natural enemies and pests in the shallot research area, consisting of 7 different orders and from 9 different families with a total of 101 arthropod species. Of the 7 types of orders, namelyOrthoptera: Dissosteira (Grasshopper) 21 and Gryllidae (Crickets) 7, Odonata : Orthetrum sabina (Green Dragonfly) 6, Araneae : Oxyopidae (Spiders) 11, Hemiptera : Neotoxoptera formosana (Leek Aphid) 23, Lepidoptera : Spodoptera litura (Armyworm) 7, Diptera : Napomyza lateralis (Leaf Flies) 9 and Atherigona sp (Seed Flies) 10, Coleoptera : Coccinellidae (Koksi beetles) 7.

The total number of predator individuals found in shallot fields was 45 individuals with 4 types. Flowering plants have the ability to attract natural enemies because they function as a source of food or shelter (Septiani and Aminah, 2021). The number of insect pests found was 56 individuals with 5 types of pests.The influence of insect diversity around shallot plantations on Spodoptera exigua is complex and depends on various factors, including the number and type of natural enemies, availability of food sources, and ecosystem conditions. FromThe results of observations of the dominant insects found on the research land were Dissosteira (Grasshopper) and Neotoxoptera formosana. The number of insects identified from the land is influenced by the climate in the surrounding environment, such as humidity. According toWardani (2016) stated that air humidity affects insect life directly or indirectly.

Species diversity was obtained using the Shannon-Wiener diversity index formula, in Soedijo and Pramudi (2015). Based on the results of the diversity index calculation from table 2, it showsThe level of arthropod diversity analyzed using the Shannon-Wiener diversity index shows a figure of 2.07%which is included in the medium category because the diversity index is in the range 1<H'3, According to Fachrul (2007), the value of H1≤H≤3 indicates that the species diversity is moderate.Diversity in an agroecosystem is expected to create stability, thus avoiding the dominance of one species which will cause imbalance and can lead to an explosion of pests (Henuhili & Aminatun, 2013).

## 4. CONCLUSION

The conclusion of this research shows that observations of the effect of refugia intercropping on the intensity of pest attacks on plants show varying results. During the 1st week of observation, there was no intensity of attacks occurring. At Weeks 2, 3, 4 and 5, attacks appeared with the highest attack intensity being 1.25% in treatment P0.Meanwhile, treatment P2 (Zinnia) showed the lowest pest attack intensity of 0.31%.The intensity of refugia attacks on shallot plants is included in the criteria for a very low level of attack.Kbecause the percentage of attacks for these treatments ranges between>0-≤10%.Apart from that, in terms of population density of S. exigua, treatment P0 showed the highest population density compared to other treatments. Treatments P1 and P2 were able to produce optimal results in suppressing the S. Exigua population. Arthropod diversity in the refugia intercropping system produces an index of 2.07% which indicates a moderate level of species diversity, with values in the range H1≤H≤3.From the research results, it was found that the diversity of pests and predators can be influenced by refugia plants planted in shallot experimental fields using an intercropping system.

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