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Parasitism capacity of telenomus sp. (hymenoptera: scelionidae) on spodoptera frugiperda, in refugia system

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ABSTRACT

Fall armyworm (*Spodoptera frugiperda*) is one of the pests that attacks maize. There are many ways to control this pest problem one of which is to use insecticides. However, biological control this pest with nature conservation based on the concept of integrated pest control. Refugia plants offer pest control properties based on the IPM (Integrated Pest Management) concept by providing food for parasitoids as the natural enemies. This study aimed to know capacity parasitism of egg parasitoid *S. frugiperda* in refugia system. This research uses non-factorial randomized group design (RGD) study, the number of *S. frugiperda* egg parasitoids on maize fields with refugia plants around it was counted. There were 5 treatments with 5 replications applied in this study: Control/without refugia, maize plants with red refugia (*Zinnia elegans*), maize plants with yellow refugia (*Melanpodium paludosumi*), maize plants with white refugia (*Turnera subulata*), maize plants with red refugia, yellow and white. This study found two species of *S. frugiperda* egg parasitoids namely *Telenomus remus* Nixon (Hymenoptera: Scelionidae) and *Telenomus dignus* (Hymenoptera: Scelionidae) in the field. The overall rate of parasitism egg *S. frugiperda* was no significant effect. The treatment of maize plants with white and mixed-colour refugia (red, yellow, white) showed the highest egg parasitization at 15 days after planting (DAP). Meanwhile, the dominance of *Telenomus remus* Nixon parasitoid was at an average of 0.202% and the lowest dominance of *Telenomus dignus* at 0.030%.

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1. INTRODUCTION

S. frugiperda originated in America and then spread to various countries and became a pest in maize plants in Indonesia, this pest is *S. frugiperda*. This pest was first found in early 2019 in Sumatra [1]. *S. frugiperda* is an invasive pest that attacks corn crops. This pest has fast distribution so it spreads quickly. As a result, this pest has caused a loss of corn yields for farmers. Based on research [2] *S. frugiperda* often attacks the growing point of maize plants, leading to the failure of young shoot and leaf formation. Due to its high feeding ability, its larvae quickly consume young maize leaves in the stalks of maize plants. Therefore, the detection of this pest is rather challenging in a small population.

As long as this problem arises, there are many ways to overcome this pest problem one of which to control of *S. frugiperda* relies on the use of insecticides. In Africa, lambda-cyhalothrin, cypermethrin, monocrotophos, malathion, et were commonly used to counter the pest attack [3].

Unfortunately, the continuous use of insecticides in controlling *S. frugiperda*, has made the pest resistance. Refer to research [4] presented the resistance of *S. frugiperda* to carbamate, organophosphate, and pyrethroid class insecticides in Brazil, Florida, Puerto, and Kenya.

To address this problem, pest control that is more environmentally friendly and supportive to the nature conservation based on the concept of integrated pest control is required. Integrated Pest Management (IPM) is a biological control that makes use of natural enemies of the pest. The population of pests 'natural enemies can be increased by improving the ecosystem. As the natural enemies of *S. frugiperda*, refugia plants can be planted around maize plants. Planting refugia plants around corn fields is one part of habitat management.

Habitat management will indirectly increase the population of natural enemies of pests around the plantations, by providing food and a diversity of food sources to create habitat or shelter for natural enemies [5]. Flowering plants that are planted can stimulate the presence of natural enemies around corn planting. Natural enemies can stimulate the presence of natural enemies around maize plants. Natural enemies will be attracted by the morphological characters and physiological characteristics of flowers such as size, shape, color, fragrance, flowering period, nectar, and pollen[6]. Refugia plants also emit volatile compounds that attract natural enemies to find hosts[7].

Based on research [8] refugia plants have a good impact on the parasitation rate of rice stem borers. Many parasitoid populations were found in the treatment with refugia *Turnera subulata*. So it is interesting if refugia is also zused for control *S. frugiperda*. Refer to research [9] the presence of sunflower refugia is quite attractive to predators. The flowerring plant attracts the presence of predators and has the potential as an alternative habitat. [10] said that planting refugia around cabbage crops can increase the effectiveness of parasitoids, so they need to be present throughout the growing season. Flowering plants provide source of carbohydrate feed which can increase the population of parasitoids[11]. Making it easier for parasitoids to find sources of nutrition for better health [12]. It is expected that the presence of refugia plants around corn plantations can be a source of food for parasitoids so that the population of *S. frugiperda* pests can be controlled.

Refer to research [13] There are approximately 150 species of parasitoids that can parasitize *S. frugiperda* eggs. Among them, *Telenomus remus* Nixon (Hymenoptera: Scelionidae) is the most prominent parasitoid of *S. frugiperda* egg. Based on research [14] that *Telenomus remus* is parasitoid with adequete flying ability and ability to find its host[15]. Parasitoid *Telenomus* sp is an egg parasitoid parasitizes the egg of *S. frugiperda*[16]. In Kenya, *Telenomus* sp. were found to be more dominant (69.3%) than *Trichogramma* sp (20.9%)[17]. *Telenomus* sp is one of the appropriate biological control agents as this parasitoid brings less damage [18]. *Telenomus remus* has been widely released in nature to control the attack of *S.frugiperda* in maize crop in Venezuela since the 1900s as one of the IPM concepts[19].

Integrated pest management (IPM) applied in this study is the concept of refugia planting. The increased attack of *S. frugiperda* pest in the field comparable to the prevalent use of insecticides and cause resistance of *S. frugiperda* pests to several types of insecticides. To resolve this problem, we used one of the IPM concepts to create microhabitats for natural enemies through the use of refugia plants. We hypothesized that the presence of refugia plants will bring many *S. frugiperda* egg parasitoids around the corn plantation. So that, it can reduce the population of *S. frugiperda* pests through a biological control approach. Therefore, the ability of the parasitoid to parasitize the eggs of *S. fruiperda* in maize crops planted with refugia plants around was examined.

2. RESEARCH METHOD

2.1 The study site and time

This research was conducted from June 2022 to December 2022 at the maize crop fields in Desa Saentis, Percut Sei Tuan District, Deli Serdang Regancy. The identification of egg parasitoids of *S. frugiperda* was done at the Biosystematic and Evolution Laboratory, The Indonesian Institute of Sciences (LIPI) Cibinong, West Java.

2.2 Research materials and tools

The equitment used in this study consist of three groups: field tools, laboratory instruments, and supporting tools. In this experiment, we used all of eggs of *S. frugiperda* were collected from plantations. The maize crop was Pertiwi-3 variety maize seeds, while the refugia flower seeds were (*Melanpodium paludosumi, Zinnia elegans, Turnera subulata*). This study also used metil asetat for parasitoids, alcohol 70% to preserve parasitoids from experiment, urea fertilizer, NPK fertilizer, compost, etc. Several tools were used, including microscopes to identify parasitoid, glass bottles, cameras as dokumentation, identification books, a knife, scissors, tape measure, tweezers, plastic containers with height of 7 cm and diameter of 7 cm, etc.

2.3 Procedure

This study was performed using non-factorial randomized group design (RGD), consisting of 5 treatments with 5 replications: R0 (Maize plants without refugia/ control), R1 (Maize plants and red refugia) (*Zinnia elegans*), R2 (Maize plants with yellow refugia) (*Melanpodium paludosumi*), R3 (Maize plants with white refugia) (*Turnera subulata*), R4 (Maize plants with red, yellow and white refugia).

Maize seeds were planted with a spacing of 70 cm x 20 cm on plots 5.6 meters in length and 2.5 meters in width. The gap between each block was set at 5 meters, with a total of 25 plots and 80 plants per plot. The total population of the maize plants were 1950 plants. Then, maize plants were observed for growth until data collection was complete.

2.4 Research implementation

The research was initiated by clearing up the land and forming the plots. The plots were then planted with refugia flowers. When refugia plants started to bloom, maize seeds were planted as determined. Fertilizers were applied based on the recommended dosage. Plant maintennace starts with watering the plants, replanting, weeding, and fertilizing the plants. These activities are carried out until the corn plants enter the reproductive period.

2.5 Collecting the Eggs of *S. frugiperda*

Egg group samples were collected in the morning (07:00-09:00) from maize aged 5-40 days after planting (dap) at five-day intervals. The egg-infested leaves were then clipped and put into a 270 ml tube. The collection of egg groups was randomly carried out on 10% of the total populations of maize plants. Using a W zigzag scouting pattern [20].

2.6 Storing the egg group

The egg groups of *S. frugiperda* was collected then put into a tube which was covered with gauze to be stored, and brought to the laboratory. The eggs were incubated at room temperature until they hatched and they hatched to be later collected and observed for identification.

2.7 Identification of Parasitoid

The identification of parasitoids was performed by observing preserved parasitoid specimens. Based on the morphological characteristics of the parasitoids such as the shape and venation of the wings, legs, and type of antennae on Leica DMC5400 digital microscope, a Leica Z6 APO digital camera and the LAS.V.4.13.0 (Build:310) connected to the computer. The reference for the parasitoid identification was [21] and several scientific articles that discussed the key to the determination of *Telenomus* species.

2.8 Percentage of egg parasite *S. frugiperda*

To investigate the degree of parasitization, the unhatched eggs in a group were treated with 70% alcohol to remove their waxy coating. Next, the hairs covering the egg clusters were carefully separated using a needle and the number of non-hatched eggs was counted under a microscope[22]. The level of parasitization was then determined by expressing the percentage of parasitized egg groups and the percentage of parasitized eggs. The calculate the parasitization rate of the eggs, a modified formula was used, which was developed by [23].

$$N=\sum \frac{nA}{nA+nB} \times 100\% \quad (1)$$

Where:
N= Percentage of parasitoid
nA= number of parasitized eggs
nB= Number of egs that are not parasitized

2.9 Dominance of Parasitoid
Parasitoid dominance was calculated to determine the dominant egg parasitoid species of *S. frugiperda*, using Simpson's formula [24].

2.10 Data analysis
ANOVA test of variance was performed in the data analysis. The results showed significant results which were then followed up with LSD test at 5% significance value[25].

3. RESULTS AND DISCUSSIONS
3.1 Percentage of egg parasitoid *S. frugiperda*
Table 1 presents the percentage of parasitoid egg parasitization. Meanwhile, Table 2 show summary of F value of parasitation rate of *S. frugiperda* egg parasitoids. Treatment using colorful refugia flower pants significantly affected the percentage of *S. frugiperda* egg parasitoids at 15, 30, 35, and 40 days after planting (DAP). The average percentage of parasitoid eggs of *S. frugiperda* against the color treatment of refugia flowers (Table 1).

Table 1. The average percentage of *S.frugiperda* egg parasitoids

Treatment	The average percentage of *S. frugiperda* egg parasitoids							
	5 dap	10 dap	15 dap	20 dap	25 dap	30 dap	35 dap	40 dap
R0	0	0,618	0,738 cb	0,779	0,707	0,707	0,738	0
R1	0	0,762	0,741 b	0,758	0,707	0,707	0,757	0
R2	0	0,766	0,730 dc	0,734	0,746	0,757	0,767	0
R3	0	0,772	0,837 a	0,847	0,799	0,784	0,817	0
R4	0	0,721	0,836 a	0,784	0,776	0,735	0,761	0

Note: Numbers followed by different notations in the same clumn and observation time show significant differences in the 5% LSD test.

Table 2. summary of F value by the degree of significance using a General Linear Model Analysis of Variance (ANOVA) of parasitation rate of *S. frugiperda* egg parasitoids

SD	df	F-value							
		3 dap	10 dap	15 dap	20 dap	25 dap	30 dap	35 dap	40 dap
Block (N)	4								
Treatment (P)	4	0.00^{tn}	0.49^{tn}	3.17^{*}	0.64^{tn}	0.94^{tn}	0.96^{tn}	0.55^{tn}	0.00^{tn}
Error	16								
Total	24								

Table 1 and Table 2 present the results of data analysis, showing a significant effect of treatment on the percentage of parasitoid egg parasitization at 15 DAP. Treatment R3 (maize with white refugia flower) (*Turnera subulata*) had the highest mean value of 0.837, which was significantly different from treatment R0 (maize without refugia/ control), R1 (maize with red refugia flower) (*Zinnia elegans*), and R2 (maize with yellow refugia flower) (*Melanpodium paludosumi*). The high level of parasitization observed in treatment R3 can be attributed to the flower characteristics of *Turnera subulata*.

Table 2 presents the result f value of parasitization rate of *S. frugiperda* egg parasitoid. In the results of research on the role of refugia on the parasitization rate of *S.frugiperda* egg parasitoids, it was found that treatments that were significantly different were found in the 15 DAP treatment. The parasitation level of *S. frugiperda* pests in corn crops is still low. In this study we tested several levels of parasitoid parasitation on *S. frugiperda* eggs. We found that the condition of refugia plants in the field can influence parasitoids in finding hosts. This is consistent with the findings of [26] that there are several factors that influence the parasitation rate of *S. fascigera* larvae including plant location (stem and flower heads), plant traits (such as plant height and plant age) and finally environmental factors (such as plant density).

In the observation of R0 (control/maize without flower), R1(maize with red refugia flower) (*Zinnia elegans*), R2 (maize with yellow refugia flower) (*Melanpodium paludosumi*), and R4 (maize with red, yellow, and white flower) have a medium percentage of parasitoids. This could be due to the parasitoid's attraction to the white flower color (R3/ *Turnera subulata*) being higher than others. However, it is a problem that needs to be further investigated and the content of volatile compounds from each refugia flower also needs to be considered. In research [27] said the attraction of insects to flowers can be caused by the repellent compounds released by the flowers. Volatile compounds released by plants can attract parasitoids.

The high level of parasitization observed in treatment R3 (maize with white refugia flower) can be attributed to the flower characteristics of *Turnera subulata*. Similarly, refer to research [28] that composition of *Turnera subulata* and *C. sulphureus* flower plants attracted ants significantly because of the complete flower composition. The presence of refugia around maize field can provide alternative habitats and niches for insect parasitoids. Treatment R3 (maize with white refugia flower) (*Turnera subulata*) did not only serve as a source of nutrition but also attracted insects through the aroma and nectar and through the release of volatile compounds that signal the presence of potential hosts. Resercher [7] also suggested that the volatile compounds released by flowers can act as a cue for parasitoids to locate their hosts. There is positive effect on the parasitoid life span with the presence of alternative hosts, refugia plants and shelter [29]. Therefore, refugia plants, including *Turnera subulata* can be considered a beneficial strategy for promoting the natural control of maize pests.

Turnera subulata flowers in treatment R3 (maize with white refugia flower) attracted the parasitoid insects, resulting in the highest parasitization percentage among others treatments. Based on research [8] stated that *Turnera subulata* flowers with white and yellow interior and open petals make it easier for parasitoids to enter and consume the nectar inside. The attractive nature of *Turnera subulata* flowers can increase the effectiveness of refugia plants as the natural control of maize pests.

Observations on the percentage of parasites were conducted on 5 DAP and 40 DAP, obtaining an average value was 0% due to the absence of *S. frugiperda* egg clusters in the field which serve as hosts for parasitoids. Egg clusters were first observed during the second observation on 10 DAP. On the contrary, based on research [30] found *S. frugiperda* female adults began laying eggs on maize plant leaves on one week DAP. The presence of moths on maize plants is attributed to the stimulation of chemical compounds released by young maize plants, particularly phenolic compounds like vanillic acid, which act as a stimulus for adulf moths to lay eggs[31].

In this study, the population of suitable hosts was observed on 10 DAP, when the clusters of *S. frugiperda* eggs were found on the maize plants. At this point, the parasitoids started searching for the host and laid their eggs on the *S.frugiperda* eggs. The suitability of the hosts for parasitization also depends on the age and condition of the host as previously explained [32]. Therefore, lower nutrient content in the maize leaves on 40 DAP could have contributed to the decrease in the availability of suitable hosts and the percentage of parasitization could also be influenced by other factors, such as the abundance and diversity of parasitoids, as well as the environmental conditions in the field [33]. Environmental factors provide effects that are interrelated with each other so the effect can be adjusted according to existing conditions[34].

The presence of parasitoids in the field can also be influenced by physical factors including, temperature, humidity, and rainfall. *Telenomus remus* and *Telenomus dignus* have an optimal temperature range at temperatures between 20-30°C[35]. Parasitoids are affected by extreme temperatures, and any effect on the host has consequeences on the inhabiting parasitoids [36]. Under these conditions *Telenomus remus* successfully developed in both host eggs. Acording to data released by BMKG in 2022, the average rainfall in Percut Sei Tuan District during the study was high at 142.6 mm in July, 259.1 mm in August, and 167 mm in September. High rainfall has adverse effects, as the rain carries away the egg clusters and causes parasitoids to die.

3.2 The dominance of parasitoid

Based on the description of morphological character compiled by [13][37][21]. We identified *Telenomus remus* and *Telenomus dignus*. *Telenomus remus* is an parasitoid of *S. frugiperda* originating from

Amerika [37]. It is a parasitoid reported to parasitize *S. frugiperda* eggs in China [37]. While the parasitoid *Telenomus dingus* has been reported as one of the parasitoids of rice borers in India, Malaysia, and China [38].

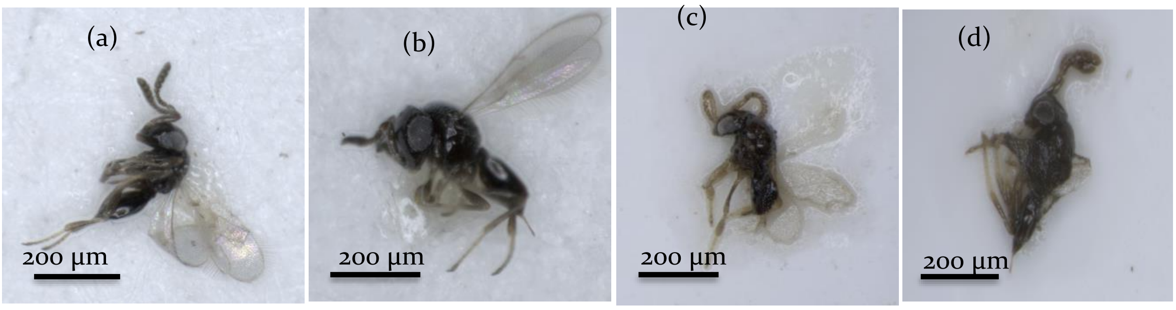

Figure 1. Morphological of *Telenomus remus* and *Telenomus dignus*: a) *Telenomus remus* male(♂), b) *Telenomus remus* female (♀), c) *Telenomus dignus* male (♂), d) *Telenomus dignus* female(♀).

Figure 1 shows, *Telenomus remus* male, *Telenomus remus* female, and *Telenomus dignus* male, *Telenomus dignus* female. Each species has different morphological characteristics. The difference between one species and another can be observed starting from the shape of its antenna, body length, leg shape, ovipositor size, wing length, mouth shape, and other characteristics. So accuracy is needed when observing.

Species identified as *Telenomus remus* has morphological characters body size ranging from 0.44-0.66 mm. The thorax is prominent or higher than the abdomen. Female antennae with funnicules 1-4 segments are very small, much smaller than the pedicel, funicules 6-8 are almost the same size. Male genetalia are short and rather broad with concave media plate near the digiri. Male limbs and antennae are paler in color than female limbs and antennae [21].

Telenomus dignus has morphological characters the abdomen of female is approximately twice as wide and narrows sharply towards the tip. The female pedicel is equal to or slightly longer than fanicula 1 and 2 combined. The limbs are bright yellow, except the front coccyx is slightly darker. Female antennae darker in color than male antennae except Scapus Half is pale. Male antennae are yellow except for 3-4 brown tip segmen. Female hind tibiae slihtly longer than 2 metatarsus.

Based on the identification results, total population of each parasitoid was calculated to determine the level of dominance based on the formula [23]. Data on the dominance of *S. frugiperda* egg parasitoids can be seen in Table 3. Table 3 presents the results of observations of parasitoid dominance during one corn-growing season. Data showed parasitoid of *Telenomus remus* the highest mean dominance of 0.202% while parasitoid of *Telenomus dignus* showed the lowest mean dominance of 0.05%. The results of the analysis (Table 3) show that the color treatment of refugia plants.

Table 3. The dominance of *S. frugiperda* egg parasitoids

Treatment	Dominance of parasitoid	
	Telenomus remus	*Telenomus dingus*
R0	0.169	0.006
R1	0.165	0.012
R2	0.174	0.026
R3	0.298	0.079
R4	0.204	0.072
Average	0.202	0.039

In Table 3, it can be seen that the dominance of *Telenomus remus* and *Telenomus dignus* parasitoids is relatively low, because the percentage of dominance is no more than 0,5%. By the literature. [24] stated that that index values range from 0-1 with the following categories: a) 0 < D < 0.5 = low dominance, b) 0.5 < D ≤ 0.75 = moderate dominance, c) 0.75 < D ≤ 1.0 = high dominance.

Table 3 indicates that the dominant parasitoid in this study was the species of *Telenomus remus* compared to the *Telenomus dignus* parasitoid. This may be attributed to the smaller body size of *Telenomus remus* between 0,44-0,60 mm, while the body size of *Telenomus dignus* ranges between 0,61- 0,78 mm [21]. The *Telenomus* genus is typically characterized by small size and simple morphology, making species identification challenging [37]. The high dominance index value of *Telenomus remus* on the refugia plant treatment showed that the parasitoid population of *Telenomus remus* around the corn plantation was high. According to [16], the parasitoid of *S. frugiperda* eggs is *Telenomus remus*. So it is very common if its population in the field is more than other parasitoids.

The role of refugia on the parasitization rate of *Telenomus remus* and *Telenomus dignus* parasitoids in this study showed that it was not significant. The population of *Telenomus remus* with the presence of refugia is still relatively small. The population *Telenomus remus* in the field was much higher than the population *Telenomus dignus*. The dominance of *Telenomus remus* egg parasitoids in parasitizing *S. frugiperda* eggs may lead to a decrease in the abundance of other parasitoid species. [39] found an increase in parasitoid dominance negatively impacted the biodiversity by reducing the populations of other parasitoids, leading to lower presence of a dominant species. Maintaining high level of parasitism by the dominant species is crucial for effective biological control.

Figure 2 presents the dominance levels of *Telenomus remus* parasitoids on treatment of refugia flower color. From figure 2, the treatment of R3(maize with white refugia flower) *Turnera subulata* at 15 DAP(Day After Planting) with a mean rate of 0.576 % parasitic level indicates that plants with white refugia (R3) differ significantly. Meanwhile, The lowest percentage of dominance level parasitoids *Telenomus remus* is the treatment Ro (maize without refugia).

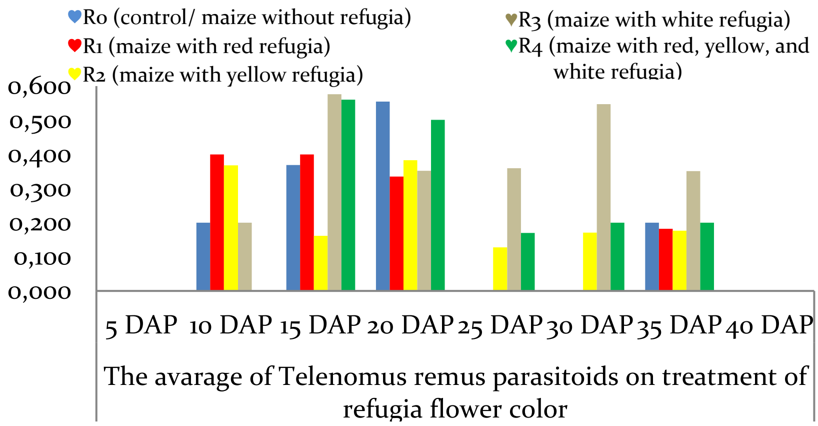

Figure 2. The Average of *Telenomus remus* parasitoids on treatment of refugia flower color

The observation showed that the best average value of *Telenomus remus* parasitoids in the field was in the R3 treatment. It should be noted that the role of refugia is not enough to be the basis for attracting parasitoids. Other factors must also be considered including physical factors in the field, especially temperature, humidity, and rainfall, which affect the parasitoid population and *S. frugiperda* (parasitoid host) [40], [41].

Meanwhile, figure 3 below presents the dominance levels of *Telenomus dignus* parasitoids in each observation, respectively. The observation result and analysis of variance showed the refugia color treatment of R3 (maize with white flower) *Turnera subulata* at 30 DAP with a mean of 0.272% indicating that the dominance of *Telenomus dignus* differs significantly. Meanwhile, the lowest dominance level of parasitoids *Telenomus dignus* is the treatment Ro(maize without refugia).

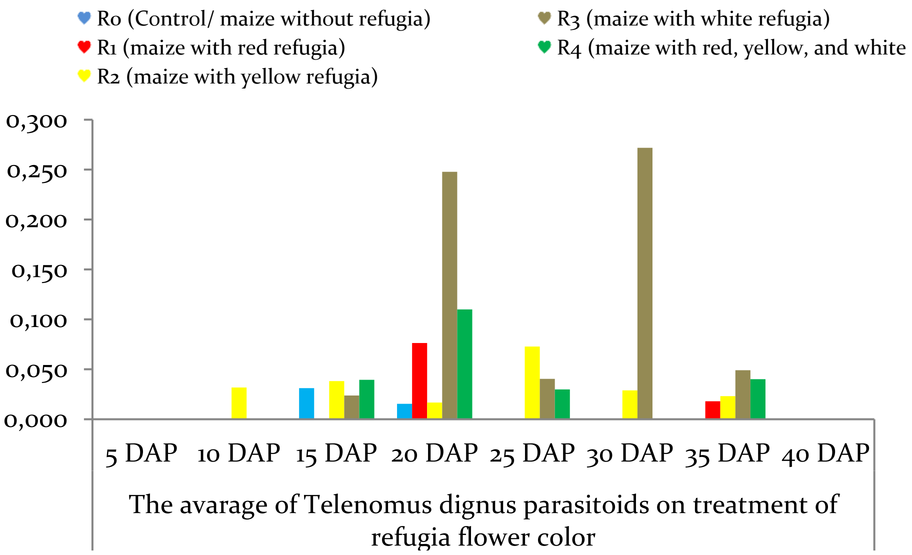

Figure 3. The average of *Telenomus dignus* parasitoids on treatment of refugia flower color

From data figure 3 about the dominance of parasitoids between 5-40 days after observation. The low dominance of *Telenomus dignus* parasitoids, namely on 5 dap and 40 dap (fig. 3) showed no one of *Telenomus dignus*. On 20 dap, *Telenomus dignus* were found in all refugia treatments, but the highest value was found in treatment R3 (maize with white refugia) *Turnera subulata*. Overall, the number of *Telenomus dignus* parasitoids found in the field is much lower than to parasitoid of *Telenomus remus*.

The term dominance refers to a situation where one type of egg parasitoid species has a higher population than other species in the same location [42]. In this study, only the parasitoid of *Telenomus remus* and *Telenomus dignus* emerged from *S. frugiperda* egg. The dominance of the *Telenomus remus* parasitoid has caused the abundance of other egg parasitoid populations to decrease in nature, research conducted by [39] found that the dominant parasitoid species would negatively affect the abundance of other parasitoid species. Since the abundance of the dominant parasitoid is greater than 1 specimen no other parasitoid species were observed according [24].

The abundance of certain species and individual egg parasitoids is influenced by the availability of herbivorous insects around the plantations as hosts for parasitoids [43]. Meanwhile, the abundance of parasitoid populations in the field againts corn plants has a positive correlation. The abundance of parasitoid populations will control the level of *S. frugiperda* pest attack in the field. Referring to research [44] that the presence and abundance of parasitoid populations in plants is influenced by the abundance of the host, the plant's flowering state, and the type of plant.

This study showed that refugia plants are important in attracting parasitoids to come and parasitize *S. frugiperda* eggs. Overall, statistically, about the dominance of parasitoid was not significantly different between Ro (control/ without refugia), R1 (maize with red refugia) *Z. elegans*, R2 (maize with yellow refugia), R3 (maize with white refugia), and R4 (maize with red, yellow and white refugia). Refugia is similar with organic farming, reducing the impact of using pesticides, contamination of agricultural products, maintaining health, and environmental suistainability[45]. The area planted with refugia provides a variety of natural enemies so the damage of plants also tends to be small. The impact the productivity will increase.

4. CONCLUSION

The results of this study indicate that the use of refugia in applying the concept of Integrated Pest Management (IPM) still needs to be studied again. The role of refugia on the parasitizing ability of egg parasitoids *S. frugiperda* show no significant differences in data regarding the percentage of the number of eggs and the number of parasitoids that appear. Our best treatment of egg parasitoids *S.*

frugiperda is R3 (maize with white refugia) *Turnera subulata*. This showed that the role of refugia in the abundance of parasitoids in the filed was also influenced by several factors such as the color of refugia flowers, aroma of refugia, nectar content, and volatile compounds which may be attractive for arthropods to stay. The abundance of *Telenomus* sp. between refugia treatments did not show too much difference. Where the species *Telenomus remus* and *Telenomus dignus* were found during observations, the ability of parasitoids *Telenomus remus* and *Telenomus dignus* to parasitize the egg *S. frugiperda* showed no significant. In the end, this research still needs to be studied, for example why parasitoids prefer certain flowers. It is necessary to test the compunds of the content of each refugia so that it is clearer why some parasitoids like these plants. The rest of the use of refugia plants needs to be pursued to support the abundance of natural enemies around planting. So this condition supports the sustainability of maize plants.

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