THE PERFORMANCE OF PREDATORY INSECT, *Sycanus dichotomus* STAL. (HEMIPTERA: REDUVIIDAE) ON COMBINATION OF PLANT HOST AND PREY

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ABSTRACT

Metisa plana Walker (Lepidoptera: Psychidae) is one of the most destructive leaf-eating pests of oil palms and the damage are causing significant loss to the oil palm industry. A study was conducted on the control of the bagworm, *M. plana*, using the predatory insect, *Sycanus dichotomus* as biological control agent in Integrated Pest Management (IPM) programs of oil palm crops. A study of longevity, number of eggs and hatchability of predatory insect *S. dichotomus* were recorded. There were three types of combination (treatment) involved in the experiment; Treatment A: 10 months old oil palm, *S. dichotomus*, *Turnera subulata* and *M. plana* as a prey; Treatment B: 10 months old oil palm, *S. dichotomus* and *T. subulata* and Treatment C: 10 months old oil palm, *S. dichotomus* and *M. plan*a as a prey. Different food sources showed different combination of suitability: Treatment A and B significant differences ($p < 0.05$) of the mean longevity compared to treatment C. Moreover, treatment A, showed a highly significant differences ($p < 0.05$) on numbers of eggs, duration of the incubation period and numbers of eggs hatching compared to treatment B and C. There was no significant difference between the life span of *S. dichotomus* male and female on treatment A (30.40 and 30.84 days) as compared to male and female on treatment B (31.08 and 31.72 days), respectively. The cultivation of the suggested beneficial plant in oil palm to maintain the abundance of natural enemies to control pests of oil palm leaves is of major issue. It is recommended that future research is necessary to assess the quality of the environment and habitat to give a more positive effect to predatory insect development.

Keywords: *Sycanus dichotomus*, beneficial plants, *Turnera subulata*, survivorship, eggs hatching, Hemiptera

ABSTRAK

Metisa plana Walker (Lepidoptera: Psychidae) adalah salah satu daripada perosak pemakan daun yang paling merosakkan daun sawit dan kerosakan yang mengakibatkan kerugian besar kepada industri sawit. Satu kajian dijalankan terhadap kawalan ulat bungkus, *M. plana* menggunakan serangga pemangsa, *Sycanus dichotomus* sebagai agen kawalan biologi dalam program Pengurusan Perosak Bersepadu (PPB) tanaman sawit. Satu kajian tentang kemandirian, bilangan telur dan penetasan oleh serangga pemangsa, *S. dichotomus* telah direkodkan. Terdapat tiga jenis kombinasi (perlakuan) yang terlibat dalam percubaan;

Perlakuan A: pokok sawit berumur 10 bulan, *S. dichotomus*, *Turnera subulata* dan *M. plana* sebagai mangsa; Perlakuan B: pokok sawit berumur 10 bulan, *S. dichotomus* dan *T. subulata* dan Perlakuan C: pokok sawit berumur 10 bulan, *S. dichotomus* dan *M. plana* sebagai mangsa. Sumber makanan yang berlainan menunjukkan kombinasi kesesuaian yang berbeza: Perlakuan A dan B perkembangan umur sangat signifikan ($p < 0.05$) berbanding Perlakuan C. Tambahan pula, Perlakuan A, menunjukkan perbezaan yang signifikan ($p < 0.05$) pada bilangan telur, tempoh inkubasi dan bilangan telur menetas berbanding dengan perlakuan B dan C. Tidak terdapat perbezaan yang signifikan antara jangka hayat jantan dan betina *S. dichotomus* pada perlakuan A (30.40 dan 30.84 hari) berbanding jantan dan betina pada perlakuan B (31.08 dan 31.72 hari) masing-masing. Isu utama adalah penanaman tumbuhan yang bermanfaat dalam sawit bagi mengekalkan musuh semulajadi untuk mengawal perosak daun sawit. Adalah disyorkan bahawa kajian masa depan adalah perlu untuk menilai kualiti persekitaran dan habitat untuk memberikan kesan yang lebih positif kepada perkembangan serangga pemangsa.

Kata kunci: *Sycanus dichotomus*, tanaman bermanfaat, *Turnera subulata*, kemandirian hidup, telur menetas, Hemiptera

INTRODUCTION

Conservation biological control enhances biological control efficacy by providing nectar, pollen, shelter, mating, and/or alternative prey to biological control agent. It is a fast-growing sub-discipline of biological control, with notable recent successes (Wratten et al. 2002). The provision of floral nectar to insect predators can enhance longevity from 18.6 and 20.6 days (male and female) in the presence of water only to 34.5 and 32.7 days (male and female) however, no eggs are produced. Insects recognize nectar and pollen which provides them with nutritional needs. The flowers in return advertise insects that fit their needs (Pichersky & Gershenzon 2002). Specifically different species of flowers are able to attract insects through visual and chemical interaction stimulants (Menzel 1985). Moreover, the plant volatiles, together with few other compounds act as determinants in insect-plant interactions (Dobson 1994).

Diversity of crop plants and the employment of the environmentally strategies can influence species richness of crop such as coffee, cocoa, and rice in agricultural areas (Donald 2004). Population of beneficial insects could increase with introducing flowering plants at the edges of oil palm plantation (Wilcove & Koh 2010). However, the predator is less studied on beneficial plants on the abundance and survivorship of insect predators as potential biocontrol agents in oil palm plantation. Basri et al. (1995) reported that the important role of parasitoids in regulating bagworms numbers, and their populations were dependant on the availability of shelter and food sources e.g. nectar provided by beneficial plants in the oil palm ecosystem. These plants were found to prolong the life span of the adult parasitoid (Basri et al. 1999). Meanwhile, Norman and Basri (2007) disclosed that in 2005, three oil palm agencies have fully adopted the technology of planting beneficial plants to control bagworm and nettle caterpillar. Four species of plants were considered to be beneficial for leaf eating and bagworm control which are *Cassia cobanensis, Crotalaria usaramoensis, Asystasia gangetica* and *Euphorbia heterophylla* (Norman & Basri 2010). However, *A. gangetica* is a pestiferous weed and is not recommended to be propagated. Ho (2002) had also quantitatively evaluated the effects of several beneficial plants in field caged trials such as *C. cobanensis* and *E. heterophylla* that are almost equal in terms of attracting parasitoids in the field. Interestingly, *C. cobanensis* has a competitive edge in that it is easier to propagate and does not need to be continually replanted every three months as *E. heterophylla* (Norman & Basri 2010).

The importance of Hemipteran predators in regulating population of pest species have been acknowledged for years (Grant et al. 1985). Predatory insect are proved as a successful biological control and is an alternative to chemical usage in agricultural systems (Jamian et al. 2017a) while helping to maintain stable arthropod communities on monoculture system (Finke & Snyder 2010). Several studies were designed to scrutinize quantitative assessment on the action of predatory insects in pest populations. This niche of investigation is amongst the most difficult yet challenging facets of biological control since information on insect-flowers interaction and performance of predatory insects are lacking in Malaysia. In this study, *T. subulata* is the most suitable beneficial plant for predatory insect, *Sycanus dichotomus*. Yusdayati et al. (2014) found two species of hemipteran predators (*Cosmolestes picticeps* and *S. dichotomus*) on three species of host plants (*Turnera* spp. *C. cobanensis* and *Antigonon leptopus*). Previous studies have shown predator insect highly preferred the odors emanating from *T. subulata* followed by *C. cobanensis* and *A. leptopus* (Jamian 2017b). Therefore, the objective of the study is to evaluate the effects of using different plant hosts and prey on the predatory insect, *S. dichotomus* performance.

MATERIALS AND METHODS

Study Sites. The study was conducted in the greenhouse, Faculty of Agriculture, Universiti Putra Malaysia. The in-house environmental conditions were at 28-31^{0}C with relative humidity of 70-80%. The predatory insects were placed within steel cages of 150 cm x 100 cm x 100 cm in size (Figure 1). To prevent the predators from escaping, each door was built in small sizes (50 cm x 100 cm). Water is sprayed regularly into cages to facilitate predators to get drinks. There were three types of combination (treatment) involved in the experiment were namely: **Treatment A**: 10 months old oil palm, 5 pairs of *S. dichotomus*, beneficial plant (*T. subulata*) and 4th instar larvae of *M. plana* as a prey. **Treatment B**: 10 months old oil palm, 5 pairs of *S. dichotomus* and beneficial plant (*T. subulata*). **Treatment C**: 10 months old oil palm, 5 pairs of *S. dichotomus* and 4th instar larvae of *M. plana* as a prey.

Figure 1. *Sycanus dichotomus* in cages for different host experiments.

The treatments were replicated five times each. Observation was done daily (0700 to 1100 h and 1600 to 1800 h) until the death of the last *S. dichotomus*. Water and prey were replenished when necessary. The eggs were collected from surface of the cages and kept in a different plastic cylindrical container in a controlled environment room were at 24-29 ºC with relative humidity of 55-85%. Upon hatching, the first instar nymphs were given moist cotton wool placed in a small petri dish. The number of eggs hatched was precisely recorded. Eggs are produced on the surface of leaves and the new nymph were produced. Succeeding parameters namely, i) longevity of adult *S. dichotomus*, ii) numbers of eggs, and iii) numbers of eggs hatching until death were determined.

Data analysis. Experiments were replicated three times with 10 individuals in each treatment for each replication. Samples were first described as means and standard errors. Data were analysed using one way (ANOVA) to compare the longevity of adult *S. dichotomus*, numbers of eggs and numbers of eggs hatched until death except gender ratio was calculated using Minitab 17.0 software. The treatment means were compared by applying Tukey's HSD test at 5% significance level.

RESULTS AND DISCUSSION

Longevity of Adult Predators

The development period for adults *S. dichotomus* fed on the three treatments were examined (Table 1). Statistical analysis revealed significant differences ($p < 0.05$) of the mean longevity within these treatments. In treatment the male and female adults of *S. dichotomus* had a longer life span (31.08 ± 1.31 and 31.72 ± 1.32 days), followed by treatment B of 30.40 ± 1.33 and 30.84 ± 1.23 days, while treatment C had the shortest life span of 17.44 ± 1.18 and 20.04 ± 1.01 days, all for male and female, respectively. However, the same decisions regarding life span are also explained by Zulkefli et al. (2004) where the mean longevity of adult stage of *S. dichotomus* was at 63.99 and 61.86 days for male and female when fed with *Corcyra cephalonica* in a laboratory condition (Zulkefli et al. 2004). In addition, Siti Nurulhidayah and Norman (2016) reported three food categories given had relatively supported the growth and development of *S. dichotomus* whereas mean life span of *S. dichotomus* of 180.6 ± 8.31 days when fed on *Tenebrio molitor*, 153.7 ± 2.31 days when fed on *C. cephalonica* and 164.3 ± 6.83 days when fed on combination sources (*T. molitor* and *C. cephalonica)*. Moreover, Jamian et al. (2011) disclosed that the mean development time of adult stages of *S. dichotomus* fed on *T. molitor* were 93.10 and 61.40 days for male and female, respectively. The life span was longer in these previous researches might due to the fact that both experiments were conducted in laboratory condition. On the contrary, our study involved experiment in field condition with combination of oil palm plantation environment, the presence of beneficial plants and bagworms, which represents the cycle of biological control. This shows that *M. plana* is a food for predators. *M. plana* is the source of food to *S. dichotomus* in the oil palm plantation.

Table 1. Longevity of adult of *Sycanus dichotomus* reared on three different treatments.

Treatment	Life span of predators (days)							
	n	Male	±	S.E	n	Female	+	S.E
A (Oil palm + beneficial plant + *M. plana)*	25	31.08	±	1.31	25	31.72	±	1.32a
B (Oil palm + beneficial plant)	25	30.40	±	1.33	25	30.84	±	1.23a
C (Oil palm + *M. plana)*	25	17.44	±	1.18	25	20.04	±	1.01b

Notes:
n = number of samples
S.E = standard error
n.s. = not significant
** = significant at 5% level

Numbers of Eggs and Hatchability

Observations of *S. dichotomus* egg production on three treatments were recorded showed significant differences ($p < 0.05$) in the number of *S. dichotomus* eggs produced in three different treatments. In treatment A, a highly significant difference ($p < 0.05$) on the duration of the incubation period was attained compared to other treatments. Likewise, a significantly higher number of eggs hatching in treatment A was obtained compared to treatment B and C.

Table 2. Mean number of *Sycanus dichotomus* eggs, hatching (day) and fecundity in three different treatments.

Treatment	No. of eggs			Hatching (day)			Fecundity		
	Mean	±	S.E.	Mean	±	S.E	Mean	±	S.E
A (Oil palm + beneficial plant + *M. plana*)	0.92	±	0.06a	16.5	±	0.88a	89.4	±	3.34a
B (Oil palm + beneficial plant)	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00
C (Oil palm + *M. plana*)	0.32	±	0.09b	14.8	±	0.53b	60.9	±	3.17b

Means followed by same letters within same column are not significantly different at P=0.05 level of probability according to Tukey's test.

With regards to treatment A and C, the eggs were laid in clusters and cemented to each other at surface of the cages, or under the leaves of oil palm but for treatment B, no eggs were produced. In female insect, reproduction generally involves producing yolky eggs, mating and then laying the fertilized eggs. Kalushkov and Hodek (2004) showed that food quality affects the developmental period as well as affecting the reproductive performance of the adults. This study shows that the egg masses were brown and always in a precise *chevron* vertical pattern, but with oblique rows (Figure 2). Our results disclosed that female *S. dichotomus* laid three or five batches of eggs during its lifetime and all of the eggs (71 to 120 eggs per cluster) hatched

in the same day. The incubation period was 11 to 25 days. Zulkefli et al. (2004) stated the female laid three batches of eggs where they hatched after 11 to 39 days, with each cluster having 15 to 119 eggs. Meanwhile, Jamian et al. (2011) reported that female *S. dichotomus* produced one to four batches of eggs during its lifetime with mean of eggs period was 16.2 days and the range of hatch-ability was between 46.6 and 77.6 eggs. Similarly, Muhamad Fahmi et al. (2018) reported the female *S. dichotomus* produced up to five batches of eggs during its lifetime, with 15% eggs hatching and 25-51eggs in each cluster. However, Ambrose (1999) described that the fecundity of *S. affanis* was 372 eggs/female, *S. pyrrhomelas* 86.80 with eggs/female and *S. versicolor* with 68.9 eggs/female.

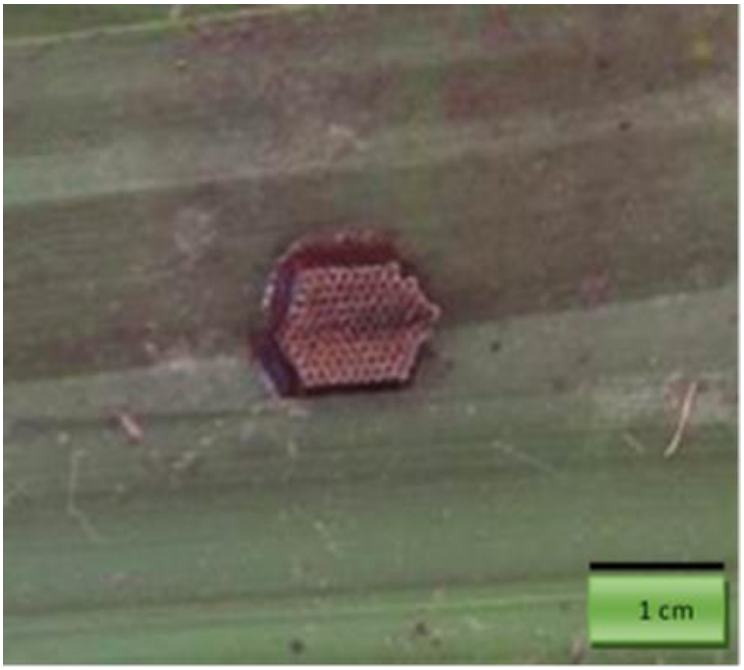

Figure 2. Egg of *Sycanus dichotomus*.

The findings of this study have increased the understanding of a combination of prey and beneficial plants that will sustain predatory predators' habitats in order to maintain the ecosystem of oil palm plantations practices to enhance farmland biodiversity (Foster et al. 2011). Effect of sublethal dose of three insecticides such as cypermethrin, deltamethrin and trichlorfon on *S. dichotomus* were found to have had a negative impact on their behaviour (Noor Farehan et al. 2018). Therefore, in order to prevent predators from becoming victims of pesticide spray, our finding provides new insights into how to maintain predatory insects' levels through insect-plant interactions. The planting of *T. subulata* species is the best practices because can improve buffer strips as habitats for predatory insects. Similarly, Yusdayati et al. (2014) shown the importance of *Turnera* spp and *C. cobanensis* on host plants to support high abundance and diversity of natural enemies.

CONCLUSION

In this study, the lifespan and fecundity of *S. dichotomus* was assessed in three different situations inside cages (semi field condition). Our findings revealed that *S. dichotomus* preferred the combination of the presence of beneficial plant and bagworm. Results show that the maintenance of *S. dichotomus* population is easy to maintain and the possible usage of *S. dichotomus* as an effective biocontrol agent of oil palm bagworm was also discussed. However, we should bear in mind that, the performance was measured in field cages, as well as the attracted to beneficial plant and number of eggs produced showed that it could perform better in an open field. Our results demonstrated the forefront and excellent performance of *S. dichotomus* in combination treatment that will contribute to the establishment of a biological control program for *M. plana* as a component of IPM, in different management systems of oil palm in Malaysia.

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