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RESEARCH ARTICLE

THE POTENTIAL OF THREE LARVAL PREDATORS AGAINST FALL ARMYWORM SPODOPTERA FRUGIPERDA (*LEPIDPTERA: NOCTUIDAE*) UNDER THE LABORATORY CONDITION

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ABSTRACT

Most cereal crops are often damaged by lepidopterous insects. Of recent, fall armyworm, *S. frugiperda* (J.E. Smith) has resulted into yield and economic loss in many African and Asian countries. This reduces farmers' income drastically and to overcome this damage, pesticides have been used which are not also environmentally friendly. Experiments were set up to collect data on the potential of three larval predators *Orius strigicollis*, *Micromus angulatus,* and *Podisus maculiventris* against *S. frugiperda.* The consumption of *S. frugiperda* larvae by three predators had highly significant effects (P≤0.05) on first, fourth, and sixth instars. No significant difference was reported between *M. angulatus* and *O. strigicollis* on second, third and fifth larval instars of *S. frugiperda. O. strigicollis* consumed more first larval instar (6.2±0.71) of *S. frugiperda* than *M. angulatus (*4.9±1.07) and *P. maculiventris* (4.2±0.74). However, *P. maculiventris* consumed more second to sixth larval instars of *S. frugiperda* than other two predators (*O. strigicollis* and *M. angulatus)*. The predator *P. maculiventris* is recommended for controlling *S. frugiperda* in their second to sixth larval instars while *O. strigicollis* in the first larval instar. It can be also concluded that fourth larval instars of *S. frugiperda* is more suitable for its control using predator *P. maculiventris* as compared to other larval instars. This study therefore recommends predator *Podisus maculiventris* to be used in control of *S. frugiperda* under laboratory conditions.

KEYWORDS

larval, predators, instars, S. frugiperda.

1. INTRODUCTION

Most cereal crops are often damaged by lepidopterous insects. Of recent, fall armyworm, *S. frugiperda* (J.E. Smith) has resulted into yield and economic loss in many African and Asian countries (Villa-Castoreña and Catalan-Valencia, 2004). This reduces farmers' income drastically and to overcome this damage, they reported to use various pesticides such as rocket, striker, dudufenos among others, which also increase the cost of production. It has also been reported that the use of pesticides has not effectively reduced the damage caused by *S. frugiperda* on crops and it also causes water contamination and pest resurgences (Hoy, 1991). The biological control agents, is therefore, smart alternative to the continuous use of pesticides in control of *S. frugiperda* in crop fields and greenhouses. Biological control agents, predators as an area of focus in this study, have advantage over pesticides because they are relatively permanent, safe, and economical and environmentally friendly.

Overall, predators always minimize the ever-increasing population of given crop pest (Chandish and Kazutaka, 2016). Although the functional response of most predators to *S. frugiperda* are well documented, information on the potential of three predators; brown lacewing - *Micromus angulatus,* minute pirate bug - *Orius strigicollis,* and spined soldier bug - *Podisus maculiventris* against *S. frugiperda* under laboratory conditions is sparse. To bridge this knowledge gap, therefore, a study was undertaken to find out the relative efficiency of these three predators on *S. frugiperda.* It was hypothesized that predation varied in larval instars of *S. frugiperda.* It was also expected that this study could show a potential for the augmentative and inundative releases of these predators to control *S. frugiperda* in the greenhouses and fields.

2. MATERIALS AND METHODS

2.1 Prey rearing techniques

The culture of *S. frugiperda* larvae started from larvae collected at corn field of Wanju, Republic of Korea. This culture was maintained at 28 ^{0}C, 70% relative humidity, and a photoperiod of 16:8h (L: D) at insect rearing laboratory, Department of Agro-Food Safety and Crop Protection, National Institute of Agricultural Sciences, Rural Development Administration (RDA), Wanju, Republic of Korea in 2019/2020. Larvae from first to six instars were fed with artificial diet (slightly modified from that reported and each instar was reared separately in order to avoid cannibalism (Lee and Boo, 1993). The eggs laid by female moth were collected using razor blade and transferred to other containers for further multiplication of larvae for the experiment.

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2.2 Larval predators

Three larval predators used for experiment: *Micromus angulatus* (ma), *Orius strigicollis* (os), and *Podisus maculiventris* (pm) were obtained from laboratory reared colonies at the same insect rearing laboratory as for the prey.

2.3 Experimental procedures

Ten (10) larvae of *S. frugiperda* in their first to sixth instars each were placed in three (3) separate breeding dishes (15 cm diameter and 7 cm high) with the artificial diet, kept at constant temperature 25±1 ^{0}C, 70% relative humidity, and a photoperiod of 16:8h (L: D) using camel brush. This was then followed by introducing one adult predator insect (3-5 days old) thus *M. angulatus*; *O. strigicollis*; and *P. maculiventris* to each of the dishes using camel brush and test tube. The treatments (predators) were replicated five times for five (5) days and ten (10) days for the first to third larval instars and fourth to sixth larval instars respectively, 24 hours after treatment. The larvae in the dishes were removed and the number of larvae consumed by the predators counted and recorded.

2.4 Statistical analysis

The treatments were subjected to general analysis of variance (ANOVA) and mean numbers of *S. frugiperda* larvae consumed by predators were compared by tukey test (P≤0.05). This was to find out if there was variation in the predation in the larval instars of *S. frugiperda* using Genstat 14th Edition and Microsoft Excel 2010.

3. Results and Discussion

The consumption of *S. frugiperda* larvae by all three predators –treatments had highly significant effects (P≤0.05) on the first, fourth and sixth instars (Table 1). However, no significant difference was noted between predators *M. angulatus* and *O. strigicollis* on the second, third, and fifth larval instars of *S. frugiperda.* This is therefore in agreement with hypothesis that the consumption of *S. frugiperda* larvae by the three predators vary with the instars. The results also show that predator *O. strigicollis* consumed more first larval instar of *S. frugiperda* than predators *M. angulatus* and *P. maculiventris*. However, predator *P. maculiventris* consumed more second to sixth larval instars of *S. frugiperda* than to other two predators (*O. strigicollis* and *M. angulatus*) (Table 1).

Table 1: Mean numbers of *Spodoptera frugiperda* larvae consumed by predators.

Predators	Number of *S. frugiperda* larvae consumed by a predator for a day (mean ± SD)					
	1st	2nd	3rd	4th	5th	6th
ma	4.9±1.07ab	2.4±0.78a	1.7±0.73a	1.0±0.44b	0.7±0.25a	1.1±0.37b
os	6.2±0.71b	2.2±0.76a	1.8±1.10a	0.3±0.47a	0.3±0.41a	0.1±0.16a
pm	4.2±0.74a	7.2±0.63b	5.8±2.45b	4.1±0.53c	2.7±0.48b	3.0±0.50c

Mean in each column followed by the same letters is not significantly different (Tukey Multiple Comparison, P≤0.05)

It was also clear that there was no uniformity in the consumption pattern of *S. frugiperda* larvae by three predators but generally, an increase in consumption of *S. frugiperda* was recorded in day 2 for *P. maculiventris* in fourth, fifth, and sixth, and *M. angulatus* in fifth larval instars a and then decline for ma in fifth, sixth and *O. strigicollis* in fourth larval instars (Figure 1). After day 3, the consumption pattern of *S. frugiperda* larval instars by predators increased, declined or remained at constant. The findings also show that predator *P. maculiventris* consumed more than three *S. frugiperda* larvae in fourth instars per day as compared to those of fifth and sixth instars (Figure 1). This implies that fourth larval instar of *S. frugiperda* is more suitable for its control using predator *P. maculiventris* as compared to other larval instars.

This suggests that predator *P. maculiventris* preferred to consume relatively bigger larval instars of *S. frugiperda* than the small ones (first larval instar) for predators *O. strigicollis* and *M. angulatus.* The findings of the current study are consistent with many previous studies which reported that nutritious preys are often associated with the reproductive advantage of the predators (Legaspi and Legaspi, 2004). Another similar study reported that the predator *Perillus bioculatus* consumed more Colorado potato beetle, *Leptionotarsa decemlineata* than house cricket, *Acheta domesticus* (Saint–Cyr and Clloutier, 1996). This shows genetically inherited preference for *L. decemlineata.* Therefore, the predator P. *maculiventris* can also increase their reproductive fitness by selecting most nutritious larval instar of *S. frugiperda.*

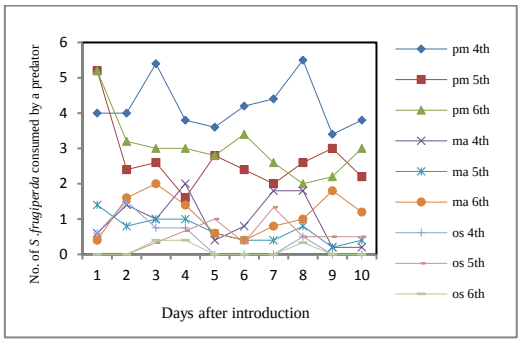

Figure 1: Average number of *Spodoptera frugiperda* larvae consumed by predators for 10 days.

4. Conclusion

It was therefore clear that *Podisus maculiventris* is more suitable predators for controlling *S. frugiperda* in their second to sixth larval instars whereas *O. strigicollis* in the first larval instar. It can be also concluded that fourth larval instars of *S. frugiperda* is more suitable for its control using predator *P. maculiventris* as compared to other larval instars. This study therefore recommends predator *Podisus maculiventris* to be used in control of *S. frugiperda* under laboratory conditions. However, more studies should be conducted on the functional response of the three parasitoids against *S. frugiperda* in the cereal crop fields as this may yield different results.

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