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TECHNICAL NOTE

Bean weevil biology in different hosts

Biologia do caruncho do feijão em diferentes hospedeiros

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ABSTRACT: The Mexican bean weevil *Zabrotes subfasciatus* feeds on several Fabaceae species, such as lima bean, common beans, peas, and cowpeas. The aim of this study was to investigate possible changes in biological parameters of *Z. subfasciatus* when submitted to hosts *Vigna unguiculata* (cowpea), *Phaseolus vulgaris* (common bean) and *Phaseolus lunatus* (lima bean). In confinement tests, oviposition, emerged adults, male and female weight, and development from egg to adult were evaluated in the three hosts. Larval viability and total number of emerged adults were lower, and the period of development from egg to adult for individuals that fed on *V. unguiculata* decreased. Thus, *P. vulgaris* and *P. lunatus* are better hosts for *Z. subfasciatus*. However, *V. ungiculata* can be used as factitious host by *Z. subfasciatus*.

RESUMO: *O caruncho do feijão,* Zabrotes subfasciatus*, se alimenta de diversas espécies de Fabaceas, como feijão-fava, feijão comum, ervilha e feijão-caupi. Este estudo buscou investigar possíveis mudanças em parâmetros biológicos de* Z. subfasciatus *submetido aos hospedeiros* Vigna unguiculata *(feijão-caupi),* Phaseolus vulgaris *(feijão comum) e* Phaseolus lunatus *(feijão-fava). Em testes de confinamento avaliou-se os parâmetros de oviposição, adultos emergidos, peso de machos e fêmeas e período de desenvolvimento de ovo a adulto nos três hospedeiros. A viabilidade larval e consequentemente o total de adultos emergidos foram menores, bem como o período de ovos a adultos para os indivíduos que se alimentaram de* V. unguiculata*. Deste modo,* P. vulgaris *e* P. lunatus são melhores hospedeiros para Z. subfasciatus*. No entanto,* V. ungiculata *pode ser utilizado como hospedeiro alternativo por* Z. subfasciatus.

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1 Introduction

The bean weevil *Zabrotes subfasciatus* Boh. (Coleoptera: Bruchinae) is the pest that causes more damage to common beans (*Phaseolus vulgaris*) during storage (Brito et al., 2015). In Brazil, its action damages 10% of all beans produced (Lorini, 2008). Larvae of this bruchid construct galleries in the beans to feed themselves, reducing grain weight and germination, besides favoring the entry of microorganisms such as fungi and mites, depreciating the product's final value (Quintela, 2002).

Zabrotes subfasciatus also feeds on other Fabaceae species, such as lima bean (*Phaseolus lunatus*), peas (*Pisum sativum*), and cowpea (*Vigna unguiculata*) (Silva et al., 2001; Girão Filho et al., 2012).

Several factors influence the choice and oviposition behavior of the pest in the host species, such as attractive substances in grains of different species and varieties, grain morphology and nutritional quality. In addition, host abundance and sites that are free from competition and predators are also influential factors (Siemens et al., 1991).

Physiological, behavioral and morphological differences have already been reported in the *Z. subfasciatus* populations associated with different varieties of a single *P. vulgaris* host (Marteleto et al., 2009). Girão Filho et al. (2012) also found differences in biological parameters, such as viable eggs and average period of *Z. subfasciatus* development, when subjected to different *P. lunatus* varieties. All insect responses, after being subjected to different hosts as food substrate, indicate that its generalist eating habit is an adaptive tool that ensures the survival of its species (Marteleto et al., 2009).

The aim of the present study was to investigate possible changes in *Z. subfasciatus* biological parameters when submitted to hosts *Vigna unguiculata* (cowpea), *Phaseolus vulgaris* (common beans) and *Phaseolus lunatus*.

2 Material and Methods

The experiment was conducted in Laboratory, in the municipality of Teresina, Piauí. The experiment was carried out under monitored conditions, in a room with 12h photoperiod, and temperature and relative humidity averaging between 29 ± 2°C and 47 ± 10%, respectively.

Insects used in the experiment were obtained from rearing kept in the laboratory in fava bean seeds. From these, a new infestation was conducted in the varieties that were used in the study, and the experiment was conducted with adults from the latter infestation. Grains used in the bioassay were first placed in plastic bags and stored in a freezer at – 10°C for seven days, in order to eliminate any external insect infestation and promote grain moisture balance. After removal from the freezer, grains were transferred to glass containers and kept in the laboratory at room temperature for ten days to reach hygroscopic balance.

In preliminary tests, different *V. unguiculata* (IT85F2687, IT81D-1045 and BRS-PASEÚ) and *P. lunatus* (UFPI 658, UFPI 671 and UFPI 222) varieties, and isogenic strains of *P. vulgaris* (Arcelina 02, Arcelina 03, and Arcelina 04) were used. Therefore, the most favorable variable to the development of the bruchid within each species was determined (Appendix 1). Thus, *V. unguiculata* IT81 –D-1045 and *P. lunatus* UFPI 658 varieties, and *P. vulgaris* Arcelina 03 strain were selected for biological testing.

The experiments were conducted in plastic containers of 6 cm in height and 5 cm in diameter where 10 grains of each bean variety were placed and two *Z. subfasciatus* couples (0-48 hours old) were confined, which were kept in contact with the grains for seven days, being removed and discarded afterwards. Counting of the total number of viable eggs (distinguishable by color, where whitish eggs were considered viable) was conducted ten days after infestation. From the 25th day after infestation, the number of insects that emerged from the grains was recorded daily, and grains were subsequently placed in a freezer. After emergencies were concluded (after seven consecutive days without emergence), insects were taken to the oven (50°C) for 48 hours. Then, the dry weight of emerging adults (g) was assessed with the aid of an analytical scale with 0.0001g accuracy. Subsequently, four groups with five males and four groups with five females were separated, per treatment.

The following parameters were assessed: total number of eggs, viable eggs, larval viability (obtained through the number of emerged insects in relation to the number of viable eggs multiplied by 100), number of emerged insects, male and female dry weight, and average egg-adult period, corresponding to the interval between the egg stage and adult emergence, calculated according to the formula below:

$$AP = \sum \text{emerged insects x day of emergence after infestation} / \sum \text{number of emerged insects}$$

The design was completely randomized, with eight repetitions. Data were submitted to analysis of variance and transformed into ($\sqrt{x + 0.5}$) or ($\sqrt{x}$) if necessary (Pimentel-Gomes, 2009). Means were compared by Tukey's test ($p < 0,05$).

3 Results and Discussion

Zabrotes subfasciatus oviposition parameters were not affected by the hosts, however, larval viability and adult emergence were significantly lower when *Z. subfasciatus* was developed in *V. unguiculata* (Table 1). Aspects such as seed color and size did not influence *Z. subfasciatus* females oviposition, and its acceptability was high for most hosts, such as chickpeas, soybeans and lentils, for example (Teixeira & Zucoloto, 2003).

Viable egg values found in this study for the *P. vulgaris* strain are very close to those found by Baldin & Pereira (2010). Therefore, although the strain aforementioned contains Arcelin, protein associated with antibiosis resistance to bruchids in beans (Baldin et al., 2007), it did not reduce egg viability.

High larval viability values in *P. lunatus* and *P. vulgaris* indicated absence of antinutritional factors, which allow for a higher percentage of viable larvae. Brito et al. (2015) and Girão Filho et al. (2014) stated that *Z. subfasciatus* is considered the main pest of *P. vulgaris* and *P. lunatus*. By contrast, *Callosobruchus maculatus*, another important stored grain pest, is the main pest of *V. unguiculata* (Akinkurolere et al., 2006).

Vigna unguiculata provided low larval viability percentage (50.32%) and low adult emergence (37.75) (Table 1) when compared to the main *Z. subfasciatus* hosts. *P. vulgaris* and *P. lunatus* equaled in these parameters, proving that these species are better hosts for the bruchid under study.

Table 1. The average total number of eggs (TNE), viable eggs (VE), larval viability (LV), number of emerged adults (NED), male (MDW) and female (FDW) dry weight, and average egg-adult period (AEAP) of *Z. subfasciatus* in *V. unguiculata*, *P. vulgaris*, and *P. lunatus* varieties under no-choice test.

Tabela 1. Médias do número Total de ovos (TNE), Ovos viáveis (VE), Viabilidade larval (LV) e total de adultos emergidos (NED), peso seco de machos (MDW) e fêmeas (FDW) e período médio de ovo-adulto (AEAP) de *Z. subfasciatus* em acessos de *V. unguiculata*, *P. vulgaris* e *P. lunatus* em teste de confinamento.

Trat.	TNE	VE	LV (%)	NED	MDW (g)	FDW (g)	AEAP (days)
V. unguiculata	91.25 a	75.12 a	50.32 b	37.75 b	0.0059 a	0.0098 a	28.02 c
P. vulgaris	106.00 a	69.00 a	85.22 a	59.00 a	0.0041 b	0.0069 b	35.39 a
P. lunatus	83.75 a	67.62 a	85.55 a	57.75 a	0.0054 a	0.0109 a	29.39 b

** Means followed by the same letter in the column do not differ statistically by Tukey's test at 1% probability ($p \leq 0.01$).

Average male and female dry weights were also significant according to the host species to which they have been subjected. *P. lunatus* equaled *V. unguiculata* statistically, having the highest average female weight (0.0109g) (Table 1). This parameter suffer influence by several factors, such as larval density within grains (Oliveira et al., 2015), and nutritional value (Marteleto et al., 2009). These factors, along with results of less larval viability and a smaller number of emerged adults, indicated that low larvae density within grains allowed them to acquire greater weight. Therefore, high adult weight recorded for *V. unguiculata* was justified, and the potential that the pest studied in this paper has to develop in that host was highlighted.

Results obtained for the average period from egg to adult showed significant differences. Adults from *V. unguiculata* had a shorter cycle (28.02 days) (Table 1). Conversely, *P. vulgaris* provided a longer cycle, despite being one of the main *Z. subfasciatus* hosts, however, this fact, can be justified by Arcelin protein presence in the variety assessed. The same strain was assessed by Baldin & Pereira (2010) and showed antibiosis at lower levels than other strains containing Arcelin in the study, prolonging the cycle to very close values to those found in this study.

4 Conclusions

Zabrotes subfasciatus oviposition behavior is not affected by the host. However, *Z. subfasciatus* biological parameters, such as average egg-adult period, emergence, and adult weight, are affected by the host.

Vigna unguiculata is a potential host to *Z. subfasciatus*.

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Appendix

The average total number of eggs, viable eggs, larval viability, number of emerged adults, male and female dry weight, and average egg-adult period of *Z. subfasciatus* in *V. unguiculata*, *P. vulgaris*, and *P. lunatus* varieties under no-choice test.

Médias do número Total de ovos, ovos viáveis, viabilidade larval, total de adultos emergidos, peso seco de machos e fêmeas e período médio de ovo-adulto de *Z. subfasciatus* em acessos de *V. unguiculata*, *P. vulgaris* e *P. lunatus* em teste de confinamento.

	Treatment	MTO	OV	VL (%)	TAE	PM (g)	PF (g)	PMOA (days)
V. unguiculata	IT 85F 2687	42.62 b	39.75 b	34.01 b	13.63 c	0.0048 b	0.0079 b	27.72 a
	IT 81-D-1045	91.25 a	75.12 a	50.32 a	37.75 a	0.0059 a	0.0098 a	28.02 a
	BRS-PASEÚ	81.50 a	70.50 a	36.23 ab	24.13 b	0.0058 ab	0.0094 a	28.84 a
	C.V(%)	11.01	12.45	29.91	18.24	4.6	3.2	3.52
P. vulgaris	Arcelina 02	75.50 b	65.75 a	26.04 c	17.25 c	0.0041 a	0.0075 a	34.90 b
	Arcelina 03	106.00 a	69.00 a	85.22 a	59.00 a	0.0041 a	0.0069 a	35.39 b
	Arcelina 04	70.37 b	61.37 a	68.18 b	41.87 b	0.0037 a	0.0065 a	37.03 a
	C.V(%)	9.95	6.47	14.4	11.26	3.21	4.57	3.50
P. lunatus	UFPI 658	83.75 a	67.62 a	85.55 a	57.75 a	0.0054 a	0.0109 a	29.39 a
	UFPI 671	79.50 a	68.62 a	83.17 a	56.62 a	0.0049 b	0.0091 b	28.59 ab
	UFPI 222	80.87 a	64.00 a	79.07 a	50.12 a	0.0047 b	0.0091 b	28.50 b
	C.V(%)	8.41	9.14	9.03	8.28	2.06	3.08	2.26

** Means followed by the same letter in the column do not differ statistically by Tukey's test at 1% probability ($p \leq 0.01$).

Authors' contribution: Jayara Dayany Costa Silva was responsible for the elaboration and the execution of the project and for the scientific writing. José Edimir Girão Filho participated in the elaboration of the project and in the reviewing of the scientific writing. Westerllanya Rodrigues Medeiros participated in the execution of the project and in the reviewing of the scientific writing. João Silvestre da Silva Neto participated in the execution of the project. Solange Maria de França contributed in the scientific writing. Paulo Roberto Ramalho Silva participated in the reviewing of the scientific writing.

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