



Status of Pigeonpea as an Alternative Host of *Piezodorus guildinii* (Hemiptera: Pentatomidae), a Pest of Soybean

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STATUS OF PIGEONPEA AS AN ALTERNATIVE HOST OF *PIEZODORUS GUILDINII* (HEMIPTERA: PENTATOMIDAE), A PEST OF SOYBEAN

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ABSTRACT

Pigeonpea, *Cajanus cajan* (L.) Millsp. (Leguminosae), was found hosting *Piezodorus guildinii* (Westwood) (Hemiptera: Pentatomidae) in Paraná State, Brazil. In the laboratory, nymphs performed better on immature pods of soybean, *Glycine max* (L.) Merrill (Leguminosae), than on immature pods of pigeonpea. Although nymphs required similar time to complete development, and attained similar weights at adult emergence, mortality was much lower on soybean (57.7%) than on pigeonpea (94.4%). Adult *P. guildinii* also performed better on soybean than on pigeonpea. Females and males showed similar longevity on both foods, but 34.5% of females oviposited on soybean compared to 10.3% on pigeonpea, with an oviposition delay of 26 days on pigeon-

pea compared to soybean. Fecundity (eggs/females) was 6.5× greater on soybean than on pigeonpea, and adult body weight gain after 14 and 28 days was 13-23% greater on soybean than on pigeonpea. *P. guildinii* also showed greater feeding activity on, and greater feeding preference for, soybean than pigeonpea. Bugs colonized soybean during summer and early autumn (January-March), and pigeonpea during autumn, early winter (April-July), and spring (October-November). These results indicate that pigeonpea, although a less preferred and less suitable plant food source of *P. guildinii* in Brazil, plays an important role to the bug's life history by serving as a temporary host.

Key Words: *Cajanus cajan*, *Glycine max*, food effect, food preference, seasonal abundance, stink bug

RESUMO

O guandu, *Cajanus cajan* (L.) Millsp. (Leguminosae) foi encontrado abrigando *Piezodorus guildinii* (Westwood) (Hemiptera: Pentatomidae) no Estado do Paraná, Brasil. Em laboratório, as ninfas tiveram um desempenho melhor quando alimentadas com vagens imaturas de soja, *Glycine max* (L.) Merrill (Leguminosae), do que quando alimentadas com vagens de guandu. Embora as ninfas tenham requerido um tempo semelhante para completar o desenvolvimento e obtido pesos semelhantes na emergência, a mortalidade foi menor em soja (57,7%) do que em guandu (94,4%). Os adultos de *P. guildinii* mostraram um desempenho melhor em soja do que em guandu. Fêmeas e machos tiveram longevidades semelhantes em ambos alimentos; 34,5% das fêmeas ovipositaram em soja e 10,3% em guandu, com um atraso na oviposição de 26 dias no guandu em comparação com a soja. A fecundidade (ovos/fêmeas) foi 6,5× maior em soja do que em guandu, e o ganho de peso dos adultos após 14 e 28 dias foi de 13 a 23% maior em soja do que em guandu. *P. guildinii* também mostrou maior atividade alimentar em, e maior preferência alimentar por, soja do que guandu. Os percevejos colonizaram a soja durante o verão e início do outono (janeiro a março), e o guandu durante o outono e início do inverno (abril a julho) e durante a primavera (outubro a novembro). Esses resultados indicam que, no Brasil, o guandu, embora sendo uma planta menos preferida e menos adequada para *P. guildinii*, desempenha um papel importante na história da vida desse percevejo, servindo como um hospedeiro temporário.

The neotropical stink bug *Piezodorus guildinii* (Westwood) (Hemiptera: Heteroptera: Pentatomidae) feeds on several species of wild and cultivated plants, mostly legumes. Among the wild plants, legumes of the genus *Indigofera* are preferred (Panizzi 1992), while among the cultivated plants, soybean, *Glycine max* (L.) Merrill, is the most important host throughout South America and particularly in Brazil (Panizzi & Slansky 1985).

We have recently observed *P. guildinii* feeding and reproducing on pigeonpea, *Cajanus cajan* (L.) Millsp. (Leguminosae), near Londrina (latitude 23°11'S, longitude 51°11'W), in Paraná State of Brazil. This legume is grown commercially on several continents (Lateef & Reed 1990). Pigeonpea is attacked by several species of pentatomids (Lateef & Reed 1990, Panizzi & Oliveira 1998, Shanower et al. 1999). In Central America, *P. guildinii* is reported to occur on this legume (Saunders et al. 1983). Because *P. guildinii* was also observed to feed and to reproduce on this legume, and because its biology has never been investigated on pigeonpea, a study was carried out on the nymph and adult performance and adult feeding preference, using soybean for comparison. We also surveyed the population of *P. guildinii* on pigeonpea to determine its abundance on this host plant throughout the seasons, and on soybean during its reproductive period.

MATERIALS AND METHODS

Laboratory Study, Nymphs

During December 1997 and January 1998, adults of *P. guildinii* were obtained from a soybean culture established in the Embrapa Field Experiment Station, at Londrina Co., northern Paraná. They were taken to the laboratory and placed in plastic boxes (11.0 × 11.0 × 3.5 cm), and fed with soybean pods (immature) cultivar 'BR-16'. Egg masses were collected on the day of oviposition and placed in 9.0 × 1.5 cm Petri dishes with moistened filter paper. On the 1st day of the second stadium (first instars do not feed), nymphs were removed and placed individually in Petri dishes. Immature pods of pigeonpea (cv. 'IAPAR-43') and soybean (cv. 'BR-16') were offered. Ninety nymphs were used for each food.

Petri dishes were placed at random in an environmental chamber maintained at $25 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ r.h. with a photoperiod of L14:D10. From January to March 1998, daily observations were made on moulting and mortality, and food was replaced every 2 days. Nymphal development time and percentage mortality from 2nd instar to adult were calculated. Fresh body weight at adult emergence was taken using an electronic balance. Data on nymphal development time and fresh body weight at adult emergence were analyzed and means compared using student's *t* test.

Laboratory Study, Adults

During March 1998, *P. guildinii* adults were collected using a sweep net from hairy indigo, *Indigofera hirsuta* L., growing on roadsides in the Londrina area. Adults were taken to the laboratory and placed in plastic rearing boxes (12.0 × 12.0 × 3.8 cm). Adults and their progenies were fed immature pods of hairy indigo. When nymphs reached adulthood, single female/male pairs were each placed in a plastic rearing box with moistened filter paper. Twenty nine pairs were fed immature pods of pigeonpea and another 29 immature pods of soybean. Food was replaced every 2 days.

During April-June 1998, daily observations were made on adult survival and reproduction. Female age at first oviposition, number of females ovipositing, numbers of egg masses, numbers of eggs/mass, and numbers of eggs hatching were counted. Adults were weighed at days 1, 14, and 28 of adult life. Data of these reproductive parameters and weight gain on both foods were analyzed using one-way ANOVA and means compared using student's *t* test and Duncan's multiple range test ($P \leq 0.05$).

From additional adults obtained in the laboratory reared on hairy indigo, feeding preference tests comparing the feeding activity on pigeonpea and on soybean seeds were conducted. In the first test, after 5 days of adult emergence, bugs were held without food for 1 day in the presence of water, and on the 7th day they were placed singly in 9.0 × 1.5 cm Petri dishes with moistened filter paper and put in an environmental chamber maintained at $25 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ r.h. with a photoperiod of L14:D10. They were offered mature seeds (turgid seeds previously embebbled in water for 12 hours) of pigeonpea (cv. 'IAPAR-43') and soybean (cv. 'Ocepar-16'), and were allowed to feed for 2 days. For each food 45 seeds were used. After this period the seeds were removed, embebbled in an acid fuchsin solution (1%) for 30 minutes. The excess of fuchsin was removed with running tap water, the seeds were air dried and examined under a dissecting microscope, and the number of flanges or external parts of the stylet sheaths (Nault & Gyrisco 1966) recorded. Mean number of flanges deposited on each type of food was calculated and compared using student's *t* test.

A second test was run, following the same procedures described above, except that in this case the seeds of pigeonpea and soybean were offered separately.

Field Survey

An additional study to survey the population of *P. guildinii* nymphs and adults on pigeonpea was conducted. From May 1996 to April 1997, weekly samples (each sample = 10 sweeps with an insect net) were taken on a pigeonpea plantation (unknown cv) at the Embrapa Station. The mean ($\pm$ SEM) number of *P. guildinii*/sample/month was calculated. Data are expressed as the mean number of bugs for each month throughout the year.

From December1996 to March 1997 weekly samples ($n = 15$ weeks) were taken on soybean using the Boyer & Dumas (1963) plant-shake method as modified by Shepard et al. (1974). It consisted of bending the soybean plants of 1 m of two parallel rows over a heavy plastic sheet put on the ground. Insects were dislodged by shaking the plants and were counted and recorded. Based on 10 weekly samples (2 m of soybean row each); the mean number of bugs/month/sample was calculated.

RESULTS

Laboratory Study, Nymphs

Nymphal development time for each stadium and for total nymphal period were similar on pigeonpea and soybean, however, the 3rd stadium showed statistically significant differences (Table 1). Total nymphal mortality was much greater on pigeonpea (94.4%) than on soybean (57.7%); the majority of nymphs died during the 2nd instar on both foods (Table 1) At adult emergence no significant differences in fresh body weight were observed (Table 1).

TABLE 1. MEAN $\pm$ SEM DEVELOPMENTAL TIME, % NYMPHAL MORTALITY, AND FRESH BODY WEIGHT OF 1-D-OLD ADULT *PIEZODORUS GUILDINII* FEEDING ON IMMATURE PODS OF PIGEONPEA OR SOYBEAN IN THE LABORATORY.

Life State	Host ¹					
	Pigeonpea			Soybean		
	Stadium duration, d	Fresh body weight, mg	Mortality ² (%)	Stadium duration, d	Fresh body weight, mg	Mortality ² (%)
2nd instar	6.0 $\pm$ 0.26	—	88.9	5.5 $\pm$ 0.13	—	40.00
3rd instar	5.8 $\pm$ 0.96 ³	—	3.3	4.6 $\pm$ 0.14 ³	—	8.9
4th instar	5.4 $\pm$ 0.68	—	0.0	5.2 $\pm$ 0.15	—	3.3
5th instar	7.8 $\pm$ 0.49	—	2.2	7.5 $\pm$ 0.14	—	5.5
Adult male	25.3 $\pm$ 1.85	38.0 $\pm$ 2.64	—	22.4 $\pm$ 0.54	42.7 $\pm$ 1.17	—
Adult female	22.5 $\pm$ 0.50	52.5 $\pm$ 3.50	TM = 94.4	23.0 $\pm$ 0.62	48.4 $\pm$ 1.43	TM = 57.7

¹Initial number of 2nd instars n = 90 on each host.
²Mortality for 2nd through 5th instars of males plus females was 94.4% for pigeonpea and 57.7% for soybean
³The only significant difference ($P \leq 0.05$, students *t*- test) was between hosts for duration of 3rd instar.

Laboratory Study, Adults

Like nymphs, adult *P. guildinii* performed better when fed soybean compared to pigeonpea. Female and male total longevities were similar on both foods, although females tended to live longer on pigeonpea, and males to live longer on soybean (Fig. 1); females survivorship, measured every 10 days, decreased faster on soybean than on pigeonpea, while males showed similar reduction in survivorship with time on both foods. More females oviposited when fed soybean (34.5%) than when fed pigeonpea (10.3%), and those that oviposited took 26 days longer to start oviposition when reared and maintained on pigeonpea compared with soybean (Table 2). Fecundity was

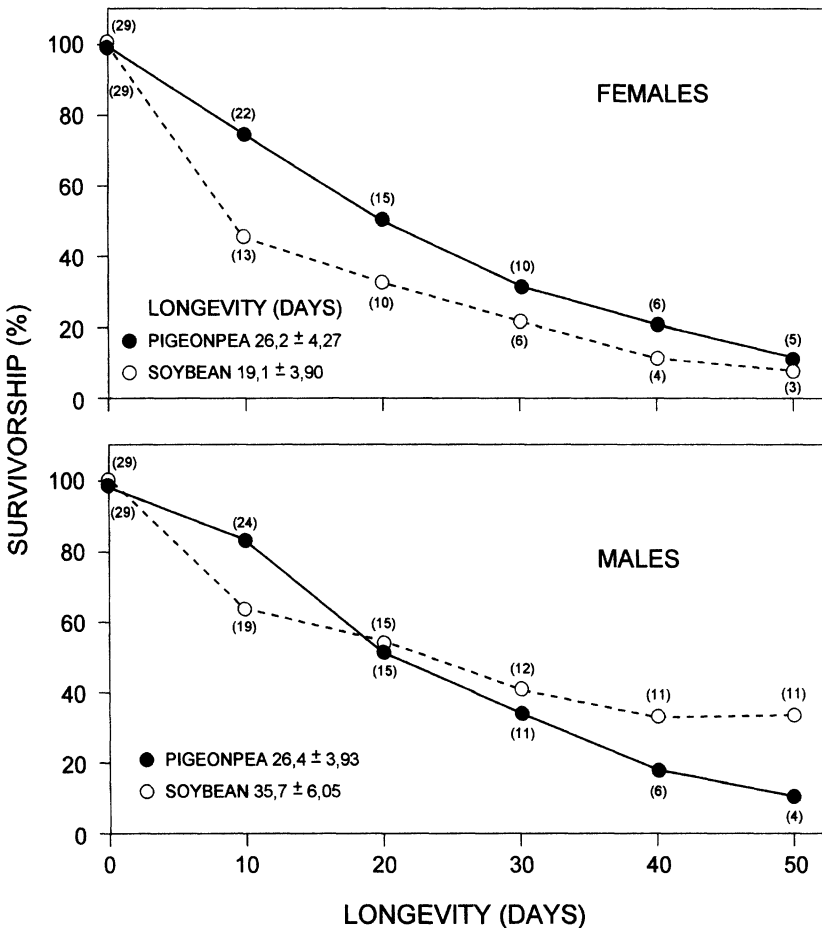


Fig. 1. Survivorship up to 50 days and total longevity of female and male *Piezodorus guildinii* feeding on immature pods of pigeonpea or soybean in the laboratory (initial number on each food $n = 29$; number of adults at each time interval in parentheses). No significant differences in longevity according to student's t test ($P \leq 0.05$).

TABLE 2. REPRODUCTIVE PERFORMANCE OF *PIEZODORUS GUILDINII* FEMALES FEEDING ON IMMATURE PODS OF PIGEONPEA OR SOYBEAN IN THE LABORATORY.

Food	Females ovipositing %	Female age (days) at first oviposition ¹ (x ± SEM)	No. per female ¹		
			Egg masses (x ± SEM)	Eggs (x ± SEM)	Egg hatch (%) ¹
Pigeonpea	10.3 [3] ²	44.0 ± 9.6*	2.0 ± 1.0*	11.0 ± 8.5*	11.9 ± 11.9*
Soybean	34.5 [10] ²	18.0 ± 2.4	6.9 ± 1.8	72.2 ± 22.5	68.7 ± 8.1

¹Means (in each column) followed by an asterisk differ significantly according to student's *t* test (*P* ≤ 0.05).

²Brackets mean number of female ovipositing.

much greater on soybean (4.9 egg masses and 61.2 eggs more) than on pigeonpea, with a difference in egg hatch of 56.8%.

After 2-4 weeks, adults were significantly heavier on soybean than on pigeonpea (Fig. 2). In general, females and males gained weight during the first 2 weeks on soybean, and maintained this higher weight after 4 weeks; on pigeonpea they did not gain weight, and males tended to lose weight.

The feeding preference tests indicated that, when foods were offered simultaneously, adults *P. guildinii* preferred to feed on soybean seeds, making a significantly (*P* ≥ 0.05) greater number of punctures (flanges) on soybean (1.87 ± 0.45) than on pigeonpea seeds (0.11 ± 0.06). When both foods were given alone, bugs also produced a greater number of flanges on soybean (3.04 ± 0.71) than on pigeonpea (0.07 ± 0.05).

Field Survey

P. guildinii colonized soybean during summer and early autumn (January-March). On this host plant nymphs peaked during February and adults during March (Fig. 3). As soybean matured, bugs started to move to pigeonpea during April, and remained on this host until early winter (July). Both nymphs and adults peaked on pigeonpea during May. No bugs were found during August and September, but during spring, in October and November, a few adults were captured on pigeonpea (Fig. 3).

DISCUSSION

Data from the laboratory and field studies suggest that pigeonpea is not a good host for *P. guildinii*, allowing only poor nymphal survival, and a much lower adult reproduction when compared to soybean. Also, pigeonpea serves only as a temporary host, particularly after the soybean harvest; most of the year *P. guildinii* was not found on pigeonpea. The percentage of nymphs reaching adulthood on pigeonpea (i.e., 5.6%) is much lower than what has been reported on other host plants, such as *Indigofera endecaphylla* Jacq. (88%), *Sesbania aculeata* Pers. (75%), *I. truxillensis* H.B.K. (73%), and *I. hirsuta* L. (42%), and more similar to what was reported on *I. suffruticosa* Mill. (16%) (Panizzi 1987, 1992). On soybean, the percentage of nymphs reaching adulthood (42.3%) was similar to what has been previously reported (47.5%) (Panizzi 1987). Nymphal mortality >50% on soybean is commonly observed, despite the high abundance of bugs on this crop in the field. Nymphal developmental time (stadia 2 through 5) on pigeonpea and on soybean (22.4-25.3 days) is similar to that reported for other hosts, except *I. suffruticosa* (28.5-30.3 days). The similar fresh body

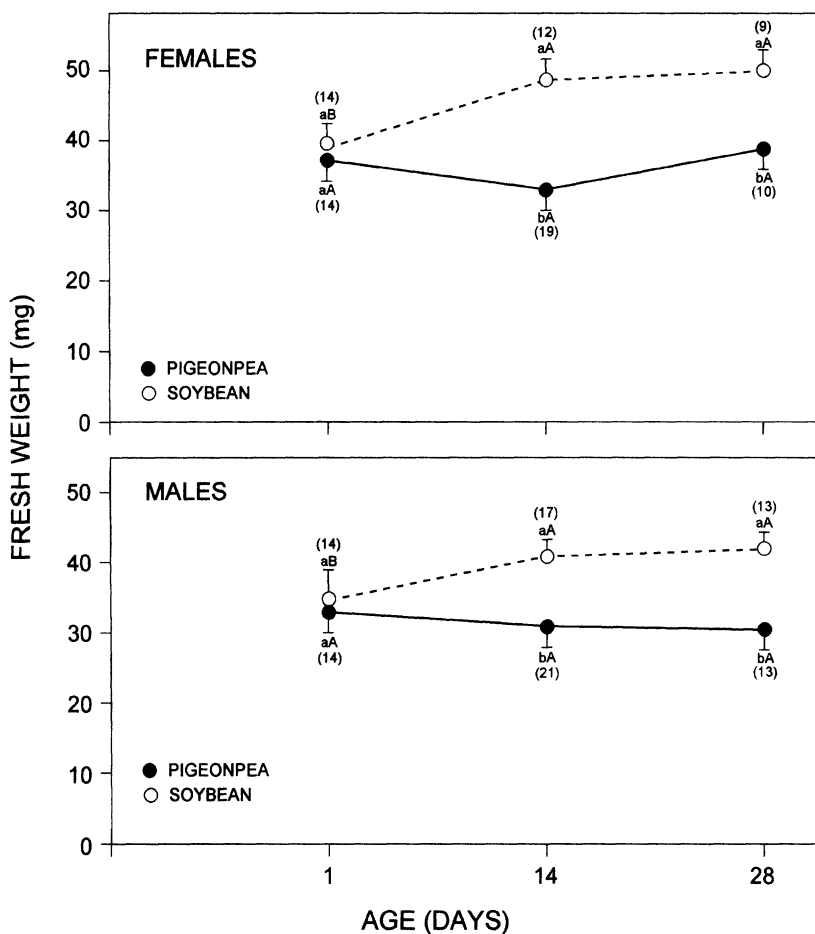


Fig. 2. Mean ($\pm$ SEM) % of fresh body weight of *Piezodorus guildinii* at days 1, 14, and 28 of adult life, on immature pods of pigeonpea or soybean in the laboratory. Means followed by the same lower case letter (between foods at each age), and upper case letter (among ages for each food) do not differ significantly using student's *t* test and Duncan's multiple range test ($P \leq 0.05$), respectively. Number of adults in parentheses.

weight at adult emergence on pigeonpea and soybean suggests that those nymphs that are able to reach adulthood on pigeonpea are able to overcome the lower quality of this food.

The fact that adult longevity was similar on both foods suggests that even when feeding on a less suitable food (pigeonpea), *P. guildinii* adults tend to have normal longevity by reducing fecundity. Another indication of the lesser quality of pigeonpea as food compared to soybean, was that *P. guildinii* adults did not gain weight on pigeonpea. Therefore, the strategy of adult *P. guildinii* seems to be to survive on pigeonpea, with a strong reduction in reproduction, to save energy to pass the unfavourable season, and wait for the next summer to colonize its main host plant, soybean. This neo-

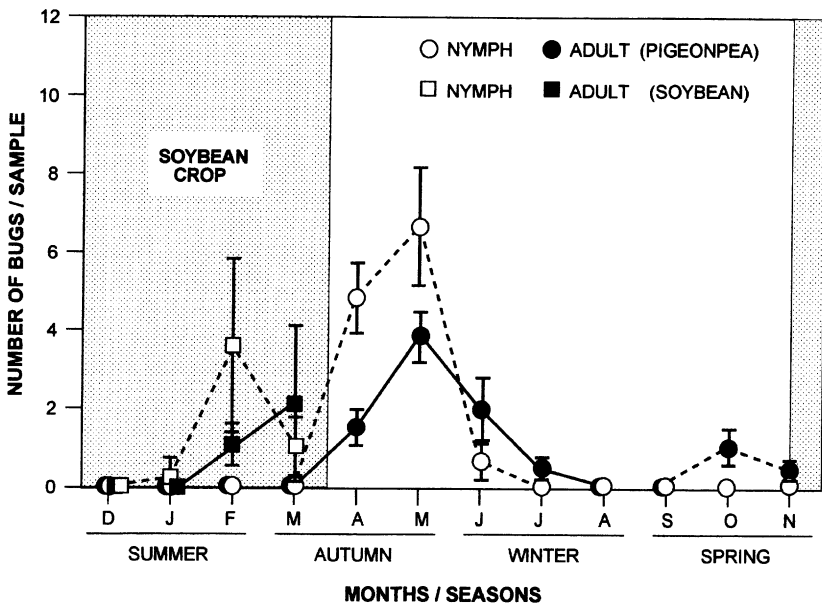


Fig. 3. Seasonal abundance of *Piezodorus guildinii* per month (mean $\pm$ SEM) captured on pigeonpea and soybean during 1996-97 in northern Paraná. On pigeonpea, one sample = 10 sweeps with an insect net; on soybean, one sample = 2m of row using the beat cloth method (Shepard et al. 1974).

tropical pentatomid has been exposed to soybean for a relatively short period of time (soybean has been cultivated in Brazil on a large scale for the last 30 years), and is not perfectly adapted to it, showing a much better performance on native legumes, such as some of the indigo species and native crotalaria (Panizzi & Slansky 1985, Panizzi 1992). Additional evidence is the fact that the many attempts to rear and maintain colonies of this bug continuously in the laboratory on soybean pods have not succeeded (A. R. Panizzi, unpublished; C. J. Rossetto, personal communication to ARP).

In the Londrina area, *P. guildinii* produces two to three generations on soybean during spring-summer. Two additional generations are produced on indigo legumes, one just after soybean harvest in autumn, and another preceding the summer (Panizzi 1997). The fact that nymphs were also found on pigeonpea during autumn, indicates that they reproduce on this host as well, but at a low rate which was confirmed by plant examination in the field. Our data from the field survey add the legume pigeonpea as a host of *P. guildinii*. In contrast to another pentatomid, the neotropical *E. heros*, which overwinters for several months during autumn-winter, *P. guildinii* moves to more preferred hosts during this time, such as native indigo and crotalaria legumes, or remains somewhat inactive on tree hosts in the woods (e.g., Sapindaceae) (Ferreira & Panizzi 1982).

The fact that *P. guildinii* was more abundant on soybean during the summer (February and March) toward the end of the reproductive period is a typical behaviour of pentatomid populations on this crop (Todd & Herzog 1980, Panizzi 1985). The movement of bugs to pigeonpea is forced by the crop maturation and harvest during April.

Finally, these laboratory and field data indicate that pigeonpea is a minor component of the life history of *P. guildinii* in the northern area of Paraná state. Nymphs and adults performed poorly on this plant, compared to soybean, on which they also preferred to feed. Therefore, pigeonpea may be considered a secondary host plant that is used as food source when the main preferred hosts, such as the indigo and croalaria native legumes or soybean are not available in the field.

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