Nota de Investigación

Insect pollination and plant guiding in *Galactia striata* (Jacq.) Urb. (Leguminosae)

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Introduction

The species *Galactia striata* was described by Alcantara and Buffarah (1982) as a tropical forage legume original from Central America. It was collected for the first time in Brazil in 1963 by the IBECC Research Institute and thereafter distributed to several research institutions. The first studies on the forage value of galactia were conducted by researchers responsible for germplasm collection and introduction at the Instituto de Zootécnia at Nova Odessa, SP. These researchers found that the seed production potential of galactia was hardly fulfilled because of the production of empty pods. They suggested that the problem could be attributed to pollinating agents.

In a preliminary study on the pollination of galactia, Nogueira et al. (1981) highlighted the importance of native bee species. However, the presence of *Apis* in galactia depended on the absence of other nearby sources of nectar or pollen.

Pollination by native, wild bees is not reliable for a seed crop because—besides the great variation observed in insect populations over sites and among seasons—pesticide use and deforestation have destroyed large numbers of bee nests (Free, 1962; Smith, 1979). Nogueira (1984) indicated that reduced fruit and seed production in many plants, including galactia, could be attributed to the absence or scarcity of native insects.

According to Free (1980), whether a crop is attractive or not to bees depends on the following factors: volume and concentration of sugars in the nectar, presence or absence of other attractive crops in the vicinity, distance between hives and crops, richness of flowers, genetic preference, requirements of the hive, recruitment by other bee workers, and quantity and quality of the pollen produced by the flower.

In studies conducted by Macedo et al. (1983) on the effects of cutting, guiding, and time of nitrogen application on galactia seed production and quality, guiding highly favored seed production in uncut plants, but this effect was lower or negligible in cut plants.

The present work was therefore conducted to study the insect species pollinating galactia, their behavior in flowers while collecting pollen and/or nectar, and the effects of open pollination and plant guiding on pod and seed production.

Materials and methods

The experiment was carried out at the Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal-UNESP, Brazil, from April 9 to June 29, 1983, using a previously established galactia seed crop.

The following treatments were used: covered crops and guiding. Half of the plots were protected with a white nylon screen placed on a framework of PVC tubes to avoid plant pollination. For guiding, three stakes were arranged on the sides of the plots, with two galvanized wires placed on each stake at 25 cm and 50 cm from the ground.

A 2 x 2 factorial, consisting of two types of covering (covered and uncovered) and two types of plant guiding (with and without tutor), was arranged in the field according to a randomized complete block design, with three replications.

Twelve plots, each measuring 2.5 m x 2.5 m each, were arranged in the field in three rows of four plots each.

The crop was observed throughout the flowering period to determine:

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- Species and number of insects visiting the crop. One specimen was collected of those species that most frequently visited the galactia and preserved in alcohol to be later classified;
- Frequency of visits throughout the day (from 10:00 h to 18:00 h), measured during 10 min each hour;
- Insect activity of the insects (gathering of pollen or nectar);
- Time spent by the most frequent bees in the gathering activity;
- Sugar concentration in the nectar;
- Development stage of the flowers visited (from flower bud to wilted flower);
- Number of opened flowers in each plot, counted once a week.

Number of pods, weight of seeds per unit area, and 1000-seed-weight were determined. Percentage of germination was determined according to Seed Analysis Norms (Brazil, 1976), but with two replications instead of the recommended. Means were compared using Tukey's test at the 0.05 level.

Results and discussion

During the flowering period of galactia (from April to June), several flowers were already open by 13:30 h. However, the peak of anthesis occurred from 15:00 h to 17:00 h, which coincided with insect frequency in the flowers. From 17:30 h onwards wilting was evident in some flowers, while others remained open until 11:00 h the next morning .

Butterflies, wasps, and bees visited the flowers to collect nectar and/or pollen. The most frequent species observed were *Apis mellifera, Megachile* (Leptorachia) *aureiventris* Schrottry, 1902; *Megachile* (Leptorachia) *paulistana* Schrottry, 1902, and *Trigona* sp. the more frequently species observed.

The importance of native bees, such as those belonging to the families Anthophoridae (*Melitoma, Exomalopsis),* Halictidae, and Apidae (*Trigona),* for the pollination of galactia was highlighted by Nogueira (1984). Bees of the genus *Apis* were not observed visiting the galactia crop, despite their high frequency in plots of *Neonotonia wightii* and *Lablab purpureus*, which were visited for collection of nectar or pollen, respectively. Table 1 indicates the bee species and the total number observed throughout the experiment period.

Table 1. **Species and total number of bees observed during the experiment.**

Species	Number of bees	% of the total
Apis mellifera	202	39.9
Trigona sp.	173	34.1
Megachile aureiventris	100	19.7
M. paulistana	32	6.3
Total	507	100.0

When the frequency of visiting bees was analyzed through polynomial regression at the 0.05 level, results showed that the number of visits to galactia decreased throughout the experiment according to the following equations:

$$Y = 5.08 - 0.06X \text{ (\textit{A. mellifera})}$$

$$Y = 3.37 - 0.04X \text{ (\textit{M. aureiventris})}$$

where Y = frequency of the visiting bees and X = time in days. The frequency of *Trigona* increased until day 38 (May 17), and then decreased according to the following equation:

$$Y = 0.10 + 0.20X - 0.002X^2$$

The frequency of *M. paulistana* remained constant throughout the experiment.

By the end of May, the number of visits made by the bees to the galactia crop was limited, attributed to the flowering of a sunflower (*Helianthus annuus)* field with a high frequency of insects, especially *Apis.* This observation confirms the observations of Nogueira (1984) that the presence of *Apis* in the galactia crop is directly related to the scarcity or absence of other attractive nectar or pollen sources.

Table 2 shows the time spent in each gathering activity by *M. aureiventris, M. paulistana,* and *Trigona* sp.

The sugar content (total soluble carbohydrates) per flower was measured in samples taken at 60-minute intervals, from 13:00 h to 18:00 h, since the solids present in the nectar of some flowers increase during the day (Erickson, 1975; Jaycox, 1970); three replications were conducted. However, the data obtained in this study showed that during this period the amount of sugar was moreless constant ($P > 0.05$). The average value of soluble carbohydrates was 116 µg/flower.

Table 2. **Species and number of bees (NB) observed, number of observations (NO), and time (T) in seconds spent in each gathering activity.**

Species	Gathering activity						
		Pollen		Nectar		Both	
	NB	NO	T	NO	T	NO	T
M. aureiventris	89	70	2.4 ± 1.3	—	—	19	5.7± 4.2
M. paulistana	10	1	5.0	6	3.0 ± 2.1	3	4.3 ± 0.5
Trigona sp.	70	70	22.1 ±18.6	—	—	—	—
Apis mellifera	—	—	4.4 ± 2.8	—	12.5 ± 6.0	—	7.1 ± 6.1

The polynomial regression, determined for the number of flowers (counted once a week), showed a linear reduction according to the following equation:

$$Y = 26.94 - 0.32X$$

where Y = number of flowers and X = time in weeks.

The number of flowers in the plants, counted once a week, was 71.3 ± 59.4 and 92.5 ± 77.9 with and without guiding, respectively. Although the plants without guiding produced 29.7% more flowers, the data were not statistically different ($P > 0.05$). However, they were similar to the number of pods per m² (Table 3), where the treatment of uncovered plants without guiding produced 31.5% more seeds than the treatment with guiding. This result does not agree with the observations of Ferguson (1978), Ribeiro (1978), and Vieira (1980), who found that the use of guiding in plants with climbing growth habit resulted in higher seed production. It is possible that the type of guiding used in this study did not enhance the use of sunlight by the plant canopy, i.e., reduced shadow and no excess moisture.

The total average number of pods was higher ($P > 0.05$) in the uncovered crop when compared with the covered crop. Furthermore, the seeds produced by uncovered plants were heavier than those produced under unfavorable pollination conditions, independent of guiding.

Higher seed production was obtained in the uncovered plants, i.e., in plants that could be visited by the pollinating agents. The seed production obtained (270 kg/ha) was higher than the average of 243 kg/ha obtained by Macedo et al. (1983). These seed yields, however, are much lower than those reported by Mattos and Alcántara (1976): 400 kg/ha.

Seed germination in covered crops was significantly higher ($P < 0.05$) than in uncovered crops in the presence of guiding, which could be attributable to more stable environmental conditions provided by the covering of plants, and to reducted dormancy in developing seeds.

Table 3. **Effect of covering and guiding on the number of pods, seed weight per unit area, 1000-seed weight, and germination of *Galactia striata* seeds.**

Treatment	Pods per m² (no.)	Seed weight (g/m²)	1000-seed weight (g)	Germination (%)
Covered, with guiding	10.5 c*	0.97 c	37.5 c	82.0 a
Covered, without guiding	6.9 c	0.67 c	38.7 c	72.0 ab
Uncovered, with guiding	161.2 b	20.31 b	44.4 a	64.0 b
Uncovered, without guiding	232.6 a	26.98 a	42.2 b	75.5 ab
Mean	102.88	12.23	40.7	73.4
C.V. (%)	10.92	34.31	19.28	14.10

* Values in the column followed by the same letter are not different ($P > 0.05$) by Tukey's test.

Conclusions

1. *Apis mellifera, M. aureiventris, M. paulistana,* and *Trigona* sp. were the species that most frequently visited the flowers of *Galactia striata.*

2. Higher seed yields per unit area and heavier seeds were obtained in uncovered plants because of insect pollination.

3. The type of guiding used did not affect seed germination in galactia.

4. Total soluble carbohydrates in the nectar were moreless constant from 13:00 h to 18:00 h, the average value being 116.0 µg/flower.

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Resumen

En la Facultad de Ciencias Agrarias y Veterinarias de la Universidad Estatal de São Paulo, Brasil, entre abril y julio de 1983, se realizó un experimento para determinar los insectos más importantes para la polinización de las flores de galactia (*Galactia striata*) y observar su comportamiento durante el tiempo que permanecían recolectando néctar o polen. También se evaluó el efecto de la cobertura de las plantas y la disposición de soportes o tutores en la producción de frutos y semillas. Las abejas más frecuentes fueron *Apis mellifera* (39.8%), *Trigona* sp. (34.1%), *Megachile aureiventris* (19.7%) y *M. paulistana* (6,3%). La cantidad total de carbohidratos solubles en el néctar no varió durante el día (13:00 a 18:00 h), siendo el promedio de 116.0 µg/flor. El soporte no afectó la producción de vainas y semillas por unidad de área ni la germinación de estas últimas. Las plantas cultivadas a la interperie, a las cuales los agentes polinizadores tuvieron acceso, produjeron una mayor cantidad de semillas por unidad de área (270 kg/ha), las que presentaron igualmente un mayor peso.

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