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Efficiency of Selected Pollinator Insects in Pollinating Faba Bean Cultivars and Their Impact on Productivity Under Basrah Governorate Conditions

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Abstract:

This study was conducted at the Agricultural Research Station of the College of Agriculture, University of Basrah, during the 2024–2025 academic year. The objective was to document the types of pollinator insects visiting the flowers of different faba bean cultivars, which belong to various insect orders.

The results showed that Syrphid flies recorded the highest visitation rate (41.6 visits), significantly surpassing other pollinator species. Among the cultivars, the New Zealand cultivar exhibited the highest average number of visits (34.4 visits).

Regarding the interaction between insect species and cultivars, the Mahali cultivar recorded the highest number of visits by Syrphid flies, reaching 50.1 visits per five minutes. The results also revealed differences in residence time of pollinators on the flowers. Apis mellifera (honeybee) ranked first with an average of 11.4 seconds, whereas Syrphid flies had the shortest duration, averaging 5.8 seconds. When analyzing the interaction between cultivar and insect species, Apis mellifera showed the longest residence time on the Veto cultivar (14.4 seconds), while Syrphid flies had the shortest time on the Mahali cultivar (4.8 seconds).

As for the number of transitions between flowers, Syrphid flies again led with an average of 6.1 transitions, compared to only 2.6 for honeybees. The Mahali cultivar recorded the highest overall transition rate (6.2 transitions), while the New Zealand cultivar had the lowest (2.8 transitions). In terms of the interaction between cultivar and insect species in transitions, Syrphid flies achieved the highest rate on the Mahali cultivar (8.7 transitions), whereas the lowest rate was observed for honeybees on the New Zealand cultivar (1.8 transitions).

These findings indicate that pollinator behavior—including visitation frequency, residence time, and transition rate—is influenced by their nectar and pollen needs, which vary among cultivars due to physiological differences. This highlights the importance of selecting cultivars that are well-adapted to local environmental conditions, promoting beekeeping, and reducing pesticide use to sustain pollinator populations and enhance the productivity of crops that depend on them.

Keywords: *Pollinator behavior, Broad bean (Vicia faba), Temperature effects, Relative humidity, Insect visits to flowers, Flower–pollinator interaction.*

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كفاءة بعض الحشرات الملقحة في تلقيح أصناف الباقلاء وتأثيرها في الإنتاجية تحت ظروف محافظة البصرة

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الخلاصة

أُجريت الدراسة في محطة الأبحاث الزراعية التابعة لكلية الزراعة – جامعة البصرة خلال العام الدراسي 2024–2025، بهدف توثيق أنواع الحشرات الملقّحة الزائرة لأزهار أصناف مختلفة من محصول الباقلاء، والتي تنتمي إلى رتب حشرية متعددة. أظهرت النتائج أن ذباب السرفيد سجل أعلى معدل زيارات (41.6 زيارة)، متفوقًا على باقي الأنواع، في حين حقق الصنف النيوزيلندي أعلى معدل من بين الأصناف، بواقع 34.4 زيارة.

وفيما يتعلق بالتداخل بين الأصناف وأنواع الحشرات، فقد حقق الصنف المحلي أعلى معدل زيارات لذباب السرفيد، مسجلاً 50.1 زيارة خلال خمس دقائق. كما بيّنت النتائج تباينًا في مدة بقاء الحشرات على الأزهار؛ إذ احتل نحل العسل *APIS MELLIFERA* المرتبة الأولى بمتوسط بلغ 11.4 ثانية، بينما جاء ذباب السرفيد في أدنى مرتبة بمدة بلغت 5.8 ثانية. أما في التداخل بين الصنف ونوع الحشرة، فقد سجل نحل العسل أطول مدة بقاء على الصنف فيتو الإسباني (14.4 ثانية)، في حين سجّل ذباب السرفيد أقصر مدة على الصنف المحلي (4.8 ثانية).

وفي ما يخص عدد الانتقالات بين الأزهار، تفوّق ذباب السرفيد بمعدل 6.1 انتقال، مقابل 2.6 فقط لنحل العسل. وسجل الصنف المحلي أعلى معدل إجمالي للانتقالات (6.2)، بينما بلغ أدنى معدل للصنف النيوزيلندي (2.8). من حيث التداخل بين الصنف ونوع الحشرة في الانتقالات، حقق ذباب السرفيد أعلى معدل على الصنف المحلي (8.7 انتقال)، في حين كان أدنى معدل من نصيب نحل العسل على الصنف النيوزيلندي (1.8 انتقال).

تُشير هذه النتائج إلى أن سلوك الحشرات الملقّحة، من حيث الزيارات ومدة البقاء وعدد الانتقالات، يتأثر باحتياجاتها من الرحيق وحبوب اللقاح، والتي تختلف كمياتها باختلاف الأصناف نتيجة لعوامل فسيولوجية. ومن هنا تبرز أهمية اختيار الأصناف الملائمة للظروف البيئية المحلية، وتشجيع تربية نحل العسل، والحد من استخدام المبيدات، لضمان استمرار وجود الحشرات الملقّحة وزيادة إنتاجية المحاصيل التي تعتمد عليها.

الكلمات المفتاحية: *سلوك الملقحات, الباقلاء (VICIA FABA), تأثيرات درجة الحرارة, الرطوبة النسبية, زيارة الحشرات للأزهار, تفاعل الزهرة والملقّح*

1. Introduction

Faba bean (*Vicia faba*), a member of the legume family (*Fabaceae*), is a sustainable crop rich in protein and energy (Mínguez and Rubiales, 2021). It is widely cultivated for human consumption due to its adaptability to diverse climatic conditions, making it one of the most agriculturally desirable crops. Faba bean also has a long history of diverse uses, serving both as animal fodder and as a highly nutritious food source (Karadavut, 2010).

Legumes in general are considered staple crops in both human and animal diets, accounting for approximately 15% of arable land and 13% of the global grain crop production (FAO, 2016; Watson, 2017). In Iraq, recent statistics indicate that the cultivated area of faba bean reached 217 hectares in 2023, producing about 334 tons of green faba beans, while 73 hectares yielded approximately 91 tons of dry faba beans (Altai *et al*., 2022; Kka *et al*., 2022; Central Statistical Organization, 2023).

It is estimated that over 100 crop species—responsible for approximately 90% of the global food supply—depend significantly on pollination by bees. Other insect pollinators, such as wasps and various wild bee species, also play essential roles in this process (Mohamed *et al*., 2024; Aouar-Sadli and Doumandji, 2008). Although it is difficult to determine the exact value of agricultural production attributable to insect pollination, some studies estimate that the global economic value of pollination services may reach nearly $200 billion annually (Eckerter *et al*., 2022; Requier *et al*., 2023).

Given the scarcity of research focusing on the role of honeybees and other insect pollinators in the pollination of faba bean crops, this study aimed to highlight the contribution of pollinating insects—particularly *Apis mellifera* (honeybee)—to the enhancement of productivity in this important crop.

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2. Materials and Methods

2.1 Study Site

This research was conducted at the Agricultural Research Station, College of Agriculture, University of Basrah, during the 2024–2025 academic year, specifically from October 17, 2024, to March 28, 2025. An 8 × 10-meter plot of land was selected and divided into three ridges, each 10 meters long, with 2 meters between ridges and each ridge 30 cm wide. Each ridge was further divided into 10 sections (1 meter each). Every cultivar occupied 2 meters: one section left uncovered and the other covered with mesh netting to exclude pollinating insects. The experiment consisted of 15 replicates distributed across the three ridges, with each cultivar

having three replicates. The research field is located in a hot, arid, semi-tropical region at coordinates 47.50°E longitude and 30.30°N latitude (Philip, 1980).

2.2 Field Preparation

All necessary agricultural practices were performed, including plowing, soil leveling, ridge formation, fertilization, and installation of drip irrigation lines. An initial irrigation was conducted before sowing to mark the planting spots and ensure proper water delivery to the faba bean seeds. The irrigation pipes were connected to the municipal water supply.

2.3 Crop Planting

Certified and treated seeds of five faba bean cultivars were obtained from the local market:

A. *Vicia faba* Local variety
B. Spanish cultivar: *LUZ DE OTOÑO*
C. American cultivar: *Vicia faba* 'HABAS' (California)
D. New Zealand cultivar: Broad Bean Basic
E. Dutch cultivar: *Vicia faba* 'Aquadulce'

Seeds were sown by hand with a spacing of approximately 30 cm between plants. The faba bean crop was challenged by heavy weed growth, particularly *Malva parviflora* and *Beta vulgaris*, which were removed manually. The main pests observed were whiteflies and aphids, causing mild to moderate infestations. To control them, the wettable powder formulation of Actara 25% was applied at a concentration of 20 g per 100 L of water. The insecticide was sprayed early in the morning, and the treatment was repeated twice during November.

2.4 Identification of Pollinating Insects

Upon flowering of the faba bean cultivars (from December 8, 2024, until the peak flowering on January 17, 2025), the most frequent insect visitors were captured using hand nets during their floral visits. Captured insects were placed into bottles containing a cyanide-based killing agent prepared specifically for this purpose. After euthanization, insects were mounted, preserved, and sent to the Natural History Museum of the University of Basrah, where they were identified by Dr. Muslim A. Abdulwahid, Assistant Professor.

2.5 Prevailing Environmental Conditions

The research site experiences cold mornings during winter, followed by gradually rising temperatures around noon and a sharp drop in the evening. Relative humidity sometimes exceeded the seasonal average. Weather data were recorded during the observation period for insect visitation frequency, residence time, and transition number from December 8, 2024, until data collection ended on March 28, 2025.

Table 1. Average temperature and humidity during the experimental period

Month	Avg. Temperature (°C)	Avg. Relative Humidity (%)
December	18.75	34%
January	22.00	46%
February	23.00	35%
March	31.30	36%

1.6 Statistical Analysis

The experiment was designed using a Completely Randomized Design (CRD) in a factorial arrangement. Data were analyzed through analysis of variance (ANOVA) using SPSS software. Means were compared using the Least Significant Difference (L.S.D.) test at a 5% probability level. Percentage data were transformed into angular values (arcsine square root transformation) before statistical analysis, following the method of Al-Rawi and Khalaf Allah (2000).

3. Results and Discussion

3.1 Types of Pollinating Insects

The study identified several species of pollinating insects that visited the flowers of different faba bean cultivars on a daily basis. These insects belonged to various taxonomic orders, including Hymenoptera (which includes the honeybee *Apis mellifera*), Diptera (which includes Syrphid flies), and Lepidoptera (which includes butterflies). The identified species and their classifications are presented in Table 2.

Table 2. Pollinating insect species observed on faba bean flowers and their taxonomic classification

No.	Common Name	Scientific Name	Family	Order
1	Honeybee	*Apis mellifera* L.	Apidae	Hymenoptera
2	Painted Lady Butterfly	*Vanessa cardui*	Nymphalidae	Lepidoptera
3	Hoverfly	*Sphaerophoria scripta*	Syrphidae	Diptera

3.1.2 Number of Pollinator Visits to Faba Bean Cultivars

Table 3. Mean number of pollinator insect visits to flowers of five faba bean cultivars during different times of the day

Cultivar	Time of Day	Syrphid Flies	Pieridae Butterflies	Apis mellifera (Honeybee)	Overall Cultivar Mean
Veto	8	38.3	13.6	18.5	26.2
	12	53.3	18.6	35.0	
	4	31.8	13.6	13.5	
Mean		**41.1**	**15.3**	**22.3**	
Mahali	8	50.0	15.1	18.5	31
	12	68.3	30.1	31.8	
	4	32.0	18.5	15.1	

Mean		**50.1**	**21.2**	**21.8**	
American	8	41.8	26.6	25.0	30.6
	12	46.6	51.6	41.6	
	4	15.3	15.1	11.6	
Mean		**34.6**	**31.1**	**26.1**	
Dutch	8	31.6	20.0	23.5	28.2
	12	61.6	38.3	31.8	
	4	15.3	15.1	16.6	
Mean		**36.2**	**24.5**	**24.0**	
New Zealand	8	41.6	21.6	20.1	34.4
	12	68.3	40.1	56.6	
	4	28.6	15.5	17.0	
Mean		**46.2**	**25.7**	**31.2**	
Overall Mean		**41.6**	**23.6**	**25.1**	—

L.S.D. Values (Least Significant Difference) at p ≤ 0.05

Source of Variation	**L.S.D. Value**
Pollinator Species	3.79
Cultivars	4.89
Time of Day	3.79
Pollinator Species × Cultivars	8.47
Pollinator Species × Time of Day	6.56
Cultivars × Time of Day	8.47
Pollinator Species × Cultivars × Time of Day	14.67

Table 3 presents the number of insect pollinator visits to faba bean cultivars. The results show a significant difference among the pollinator species. The Syrphid fly recorded the highest mean number of visits at 41.6, showing a statistically significant difference compared to other pollinators. In contrast, there was no significant difference between the honeybee (*Apis mellifera*) and the Painted Lady butterfly (*Vanessa cardui*), which recorded 25.1 and 23.6 visits, respectively.

The superior performance of the Syrphid fly may be attributed to its greater ability to withstand various environmental conditions compared to the honeybee, whose activity is more sensitive to weather factors. Syrphid flies are among the most important pollinators of flowering plants. Studies have shown that some species, especially of the genus *Eristalis*, can carry pollen loads comparable to those carried by the European honeybee (*Apis mellifera*), making them valuable pollinators—particularly in environments where bee activity is reduced due to environmental or agricultural factors (Chisausky *et al*., 2020).

Table 3 also indicates a significant difference among cultivars in the number of pollinator visits. The New Zealand cultivar recorded the highest average number of visits (34.4), which was significantly different from the other cultivars. This may be due to pollinators' preference for certain morphological or structural flower traits, or differences in nectar quantity among cultivars. Even within the same species, flower color and nectar production can vary; for example, some faba bean cultivars produce purple flowers rather than white, which may influence pollinator attraction.

In a study by Potts *et al*. (2019), it was observed that some cultivars from the family Asteraceae attracted high honeybee visitation while being largely ignored by other pollinators, benefiting bees and wasps specifically. In contrast, no significant differences were found among the Dutch, Veto, and Local cultivars, which recorded 28.2, 26.2, and 31.0 visits, respectively.

A significant interaction between cultivar and pollinator type was also observed. The highest number of visits (50.1) was recorded for Syrphid flies on the Local cultivar during a five-minute observation period. This reinforces the idea that Syrphid flies excel under varied environmental conditions and are highly effective natural pollinators. Unlike bees, Syrphid flies do not rely on fixed nesting sites, giving them more flexibility and foraging range across agricultural landscapes (Rader *et al*., 2020).

3.2 Number of Visits in December and January

As shown in Figure 1, the month of observation had a clear impact on the number of pollinator visits to faba bean flowers. Across all cultivars, the highest average number of visits occurred in January, attributed to increased flowering intensity and favorable weather conditions for pollinators, compared to December, which had fewer blooms except in early-flowering cultivars. The gradual increase in temperature and enhanced nectar production during January played a role in attracting more insects. According to Lau and Galloway (2004), the diversity and frequency of pollinators visiting flowers are influenced by the floral traits and rewards such as nectar and pollen. The more resources a plant offers, the more attractive and frequently visited it becomes to pollinators, improving pollination efficiency.

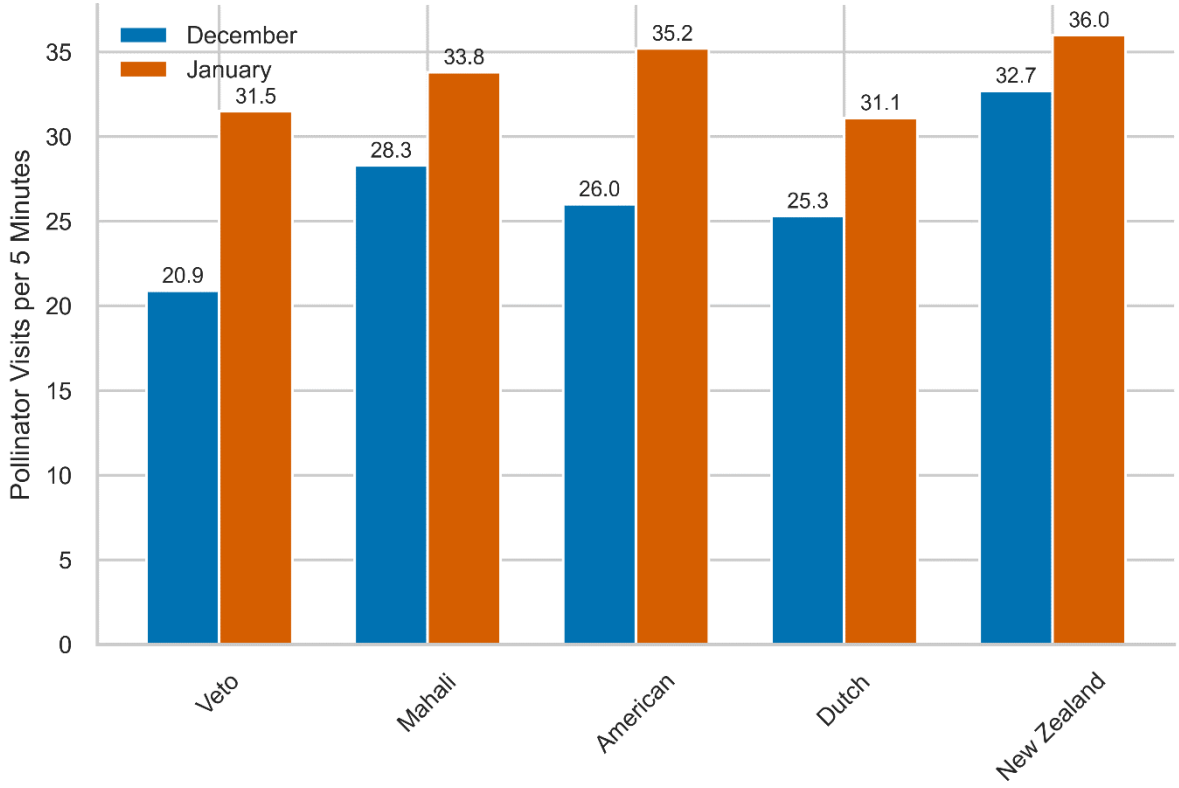

Figure 1. Number of insect pollinator visits per five minutes to faba bean flowers during December and January.

3.3.1 Duration of Pollinator Stay on Faba Bean Cultivar Flowers

Table 4. Mean Duration of stay of pollinating insects on the flowers of fava bean crop varieties

Cultivar	Time of Day	Syrphid Flies	Pieridae Butterflies	Apis mellifera (Honeybee)	Overall Cultivar Mean
Veto	8:00 AM	4.5	6.0	23.5	10.3
	12:00 PM	9.5	24.5	11.8	
	4:00 PM	3.8	1.5	8.0	
Mean		5.9	10.6	14.4	
Mahali	8:00 AM	3.0	4.8	11.5	8.6
	12:00 PM	8.6	27.1	10.0	
	4:00 PM	2.8	2.0	8.1	
Mean		4.8	11.3	9.8	
American	8:00 AM	2.8	4.6	15.8	8.9
	12:00 PM	10.3	21.1	10.0	
	4:00 PM	5.1	2.6	8.1	
Mean		6.11	9.5	11.3	
Dutch	8:00 AM	2.5	3.0	16.0	8.5
	12:00 PM	10.6	23.3	9.6	
	4:00 PM	1.6	2.5	8.0	
Mean		4.9	6.9	11.2	
New Zealand	8:00 AM	7.1	1.6	8.0	9.7
	12:00 PM	12.5	28.6	13.0	
	4:00 PM	3.0	3.6	10.0	
Mean		7.5	11.3	10.3	
Overall Mean	—	5.8	10.4	11.4	—

L.S.D. Values (Least Significant Difference) at $p \leq 0.05$

Source of Variation	L.S.D. Value
Pollinator Species	1.4
Cultivars	1.9
Time of Day	1.4
Pollinator Species × Cultivars	3.3
Pollinator Species × Time of Day	2.5
Cultivars × Time of Day	3.3
Pollinator Species × Cultivars × Time of Day	5.7

Table 4 presents the statistical analysis results of the duration of insect pollinators' stay on faba bean flowers. A significant difference was observed among the pollinator species. The honeybee (*Apis mellifera*) recorded the longest mean duration, remaining on flowers for 11.4 seconds, while the Syrphid fly recorded the shortest mean duration, at 5.8 seconds. These differences are attributed to the varying nectar and pollen requirements of each species, and their foraging behavior. For instance, honeybee workers typically collect nectar and pollen more slowly than Syrphid flies (Nimr and Shahadha, 2002).

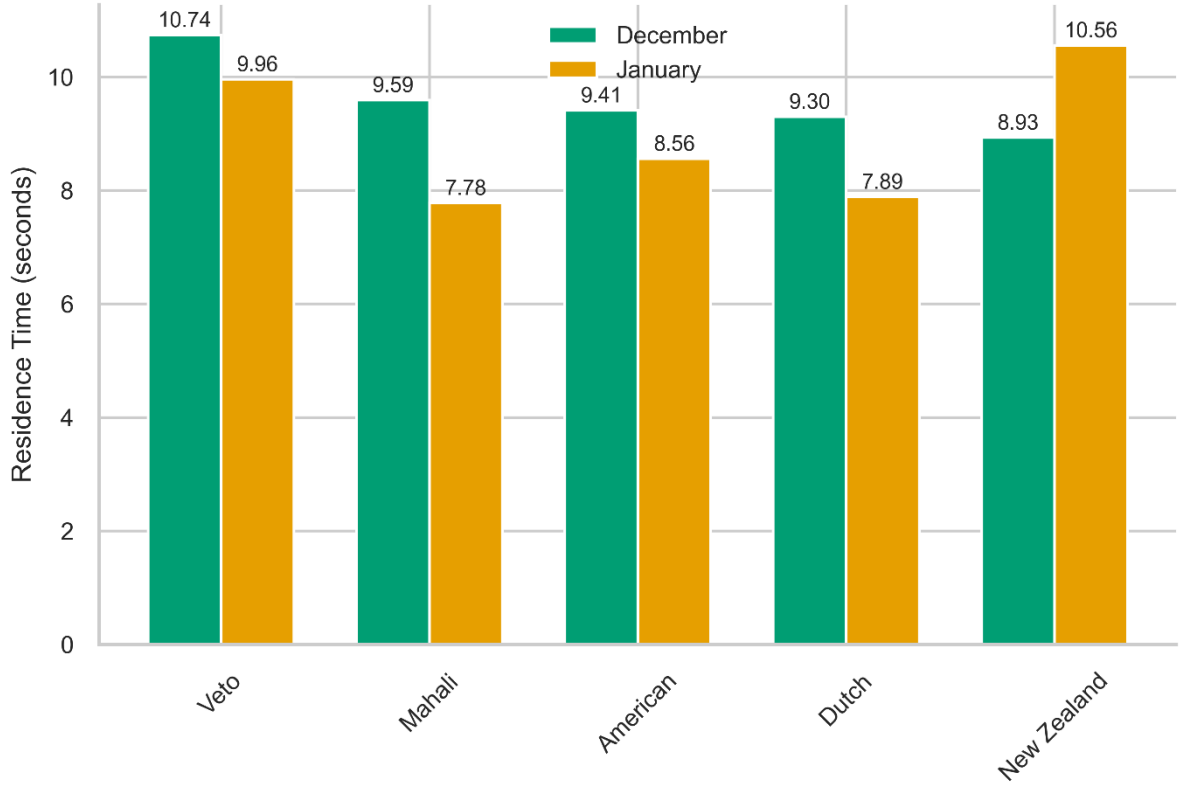

Figure (2) represents the duration of pollinating insect visits (in seconds) during the months of December and January.

The table also shows no significant differences among the faba bean cultivars in terms of pollinator stay duration. For example, pollinators remained on the Veto cultivar for an average of 10.3 seconds. However, a significant interaction between pollinator type and cultivar was observed. The longest stay duration—14.4 seconds—was recorded by Apis mellifera on the Veto cultivar, while the shortest stay—4.8 seconds—was recorded by the Syrphid fly on the Local cultivar.

These variations are linked to differences in floral rewards and accessibility. Insects feeding primarily on nectar, such as butterflies (*V. cardui*) and honeybees (*A. mellifera*), tend to spend less time on flowers, especially if the nectar is easily accessible. Both species possess long proboscises that allow them to reach deep into the floral structure where nectar is stored, facilitating rapid collection and return to the hive.

In contrast, insects collecting pollen may stay longer on the flower, particularly honeybee workers that continue foraging even after their pollen baskets are filled. Al-Naji (1980) reported that the time required by a honeybee worker to collect a full pollen load ranges from 15 to 30 minutes, depending on environmental conditions and floral abundance.

3.3.2 Duration of Pollinator Stay During December and January

Figure 2 illustrates the duration of pollinator visits to flowers during December and January. Results indicate that the Veto cultivar (a cultivar with early flowering characteristics) recorded the longest average pollinator stay in December. No significant differences were observed in pollinator stay durations among the Local, American, Dutch, and New Zealand cultivars during this month.

In January, the New Zealand cultivar ranked second in terms of longest pollinator stay, though again, no significant differences were observed among the remaining cultivars. The shorter stay durations in January are likely due to increased pollinator visitation frequency, combined with limited nectar and pollen availability, which results in shorter visits per flower.

These observations are inconsistent with findings from other studies, which suggest that differences in faba bean cultivar traits—such as floral scent, calyx size, and nectar concentration—can significantly affect pollinator attraction and visit duration. For example, Stoddard (2011) noted that certain cultivars may attract more bumblebees and other pollinators due to these specific floral characteristics.

Figure 2. Duration of insect pollinator stay on faba bean flowers (in seconds) during December and January.

3.4.1 Number of Pollinator Transitions on Faba Bean Cultivar Flowers

Table 5. Mean number of pollinator insect visits to flowers of five faba bean cultivars at different times of the day, and Least Significant Difference (L.S.D.) values at $p \leq 0.05$

Cultivar	Time of Day	Syrphid Flies	Pieridae Butterflies	Apis mellifera (Honeybee)	Overall Cultivar Mean
Veto	8:00 AM	6.6	3.1	2.5	4.7
	12:00 PM	11.3	7.1	5.0	
	4:00 PM	3.6	2.0	0.8	
Mean		**7.2**	**4.1**	**2.7**	
Mahali	8:00 AM	8.3	3.8	4.5	6.2
	12:00 PM	13.5	9.8	7.1	
	4:00 PM	4.5	2.6	1.5	
Mean		**8.7**	**5.4**	**4.3**	
American	8:00 AM	3.5	1.8	1.6	3.3
	12:00 PM	6.0	4.6	2.3	

	4:00 PM	5.5	2.0	2.5	
Mean		**5.0**	**2.8**	**2.1**	
Dutch	8:00 AM	5.0	2.3	1.5	3.4
	12:00 PM	8.6	4.6	3.6	
	4:00 PM	1.8	2.5	1.1	
Mean		**5.1**	**3.1**	**2.1**	
New Zealand	8:00 AM	2.8	2.0	1.3	2.8
	12:00 PM	7.8	2.6	2.3	
	4:00 PM	2.8	1.8	1.8	
Mean		**4.5**	**2.1**	**1.8**	
Overall Mean		**6.1**	**3.5**	**2.6**	—

Least Significant Difference (L.S.D.) values at $p \leq 0.05$

Source of Variation	L.S.D. Value
Insect Species	0.57
Cultivars	0.74
Time of Day	0.57
Insect Species × Cultivars	1.28
Insect Species × Time of Day	0.99
Cultivars × Time of Day	1.28
Insect Species × Cultivars × Time of Day	2.23

Table 5 shows significant differences among pollinator species in the number of flower-to-flower transitions on faba bean cultivars. The Syrphid fly ranked first, recording the highest transition rate at 6.1 flowers per minute, followed by the painted lady butterfly (*Vanessa cardui*), with an average of 3.5 flowers per minute. The honeybee (*Apis mellifera*) had the lowest transition rate, with an average of 2.6 flowers per minute.

The table also reveals significant effects of cultivar type on the number of pollinator transitions. The Local cultivar recorded the highest average at 6.2 flowers per minute, while the New Zealand cultivar had the lowest rate at 2.8 flowers per minute. No statistically significant differences were recorded for the remaining cultivars, which had mean transition rates of 4.7, 3.4, and 3.3 flowers per minute, respectively.

Furthermore, the interaction between cultivar and pollinator species showed significant differences. The Syrphid fly on the Local cultivar recorded the highest interaction value, with an average of 8.7 flowers per minute, while the lowest interaction was for *Apis mellifera* on the New Zealand cultivar, averaging only 1.8 flowers per minute. These differences are likely due to pollinator efficiency, floral structure, nectar depth, and pollen load capacity. Studies have shown that Diptera is the second most important insect order in pollination after Hymenoptera (bees, wasps, and ants), while Lepidoptera contribute significantly, with over 70% of wildflower species being visited by these pollinators.

Hussein (2009) noted that the density of pollinators varies throughout the day, with some species preferring early morning visits due to the nocturnal or early-morning secretion of nectar and floral scents that attract insects. The availability of pollen during daylight hours also plays a role in attracting a variety of pollinators. Additionally, flowers rich in nectar attract repeated visits

from pollinators, especially those within a single inflorescence, increasing the likelihood of effective pollination.

3.4.2 Number of Pollinator Transitions During December and January

Figure 3 illustrates the number of pollinator transitions on faba bean cultivars during December and January. The data show that the Local cultivar recorded the highest number of pollinator transitions in January, likely due to its early flowering and dense floral display.

Conversely, the Dutch cultivar exhibited the lowest number of pollinator transitions in December, which may be attributed to a lower number of floral clusters during that month. Floral density influences both the frequency of pollinator transitions and the amount of pollen carried by honeybees (*Apis mellifera*) (Irwin & Elliott, 2009).

Al-Amiri (2009) also pointed out that rapid transitions from one flower to another can result from competition among pollinators, which intensifies in environments with dense and resource-rich flowering.

Figure 3. Number of pollinator transitions (visits per minute) on faba bean flowers during December and January.

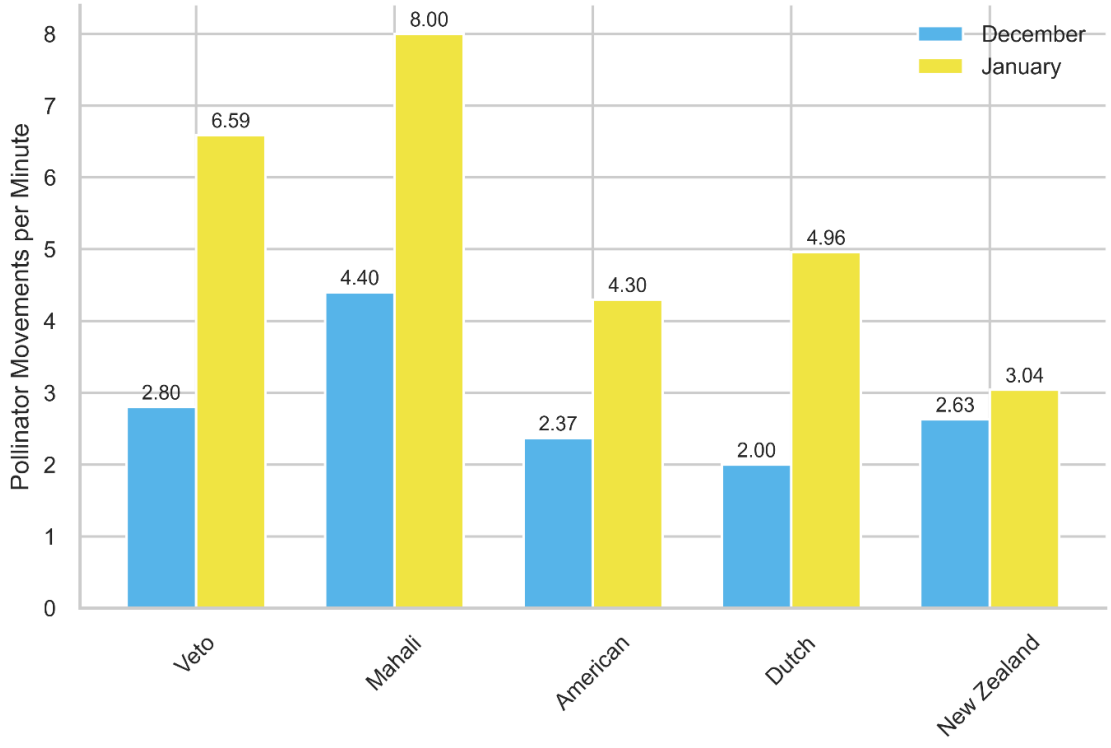

Figure (3) represents the number of movements of pollinating insects per minute during the months of December and January.

3. Conclusions

Pollinator visitation is influenced by a variety of factors, including environmental conditions and local weather patterns, as well as the quantity of nectar and pollen provided by the plant and the nutritional needs of the visiting insects for their growth and the nourishment of their offspring.

The Syrphid fly outperformed other pollinators, including the honeybee, due to its ability to withstand diverse environmental conditions, such as varying temperatures and relative humidity levels. It is important to note that crop productivity is not solely dependent on insect pollination but is also significantly influenced by the genetic traits of the plant itself.

4. Recommendations

1. It is recommended to select agricultural cultivars with improved genetic traits, characterized by high productivity and a dependence on insect pollination of no less than 60%.
2. Efforts should be made to preserve the natural habitats of pollinators, as these environments support large populations of effective pollinating insects, which play a crucial role in the successful fertilization of crop flowers. This directly contributes to improving both the quantity and quality of fruits and seeds produced.

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