*https://doi.org/10.62587/AFRJBS.3.1.2026.28-36*

ISSN: 3006-7464

African Research Journal of Biosciences

Journal homepage: http://www.afrjbs.com

Research Paper

Open Access

# Taxonomic composition and abundance of dipteran flower visitors of *Lippia javanica* in cultivated versus wild areas of Mashonaland East, Zimbabwe

Annabel Banda[1], Sarah Mukosa[2], James Machingura[3], Sija Amos Kabota[4], Edmore Utete[5] and Nokubonga Ncube[6*]

[1]Centre for Wildlife Conservation and Research, Gwanda State University, Epochmine Campus, P.O Box 30 Filabusi, Zimbabwe. E-mail: annabel.banda@gsu.ac.zw
[2]Department of Biological Science and Ecology, Faculty of Science, University of Zimbabwe, Harare, Zimbabwe. E-mail: mukosas87@gmail.com
[3]Department of Biological Science and Ecology, Faculty of Science, University of Zimbabwe, Harare, Zimbabwe. E-mail: jmachingura@science.uz.ac.zw
[4]Research, Consultancy and Publication Unit, National Sugar Institute (NSI), P.O. Box 97, Kidatu-Morogoro, Tanzania. E-mail: sija.kabota@nsi.ac.tz
[5]Department of Mathematics and Statistics, Faculty of Computational Sciences, Gwanda State University, P.O Box 30 Filabusi, Zimbabwe. E-mail: edmore.utete@gsu.ac.zw
[6]Centre for Wildlife Conservation and Research, Gwanda State University, Epochmine Campus, P.O Box 30 Filabusi, Zimbabwe. E-mail: nokubongancube00@gmail.com

**Article Info**

Volume 3, Issue 2, July 2026
Received : 02 February 2026
Accepted : 19 June 2026
Published : 25 July 2026
*doi: 10.62587/AFRJBS.3.2.2026.28-36*

## Abstract

Lippia javanica was widely used during and after the COVID-19 pandemic. Research has been conducted to address the chemical composition and cultivation of *L. Javanica*. However, research gaps remain, such as pollinator visitation to *L. javanica*, particularly dipteran pollinators, owing to the small size of the flowers. To address this gap, this study assessed dipteran flower visitors (including potential pollinators) of *L. javanica* in cultivated (treatment) and wild areas (control) in Zimbiru and Mutake villages. The research aimed to identify the taxonomic composition of dipteran flower visitors and compare their abundance in different areas. The study took place between August 2023 and June 2024. The research covered two sites. Each site had three demarcated plots, with two pan traps of the same color placed in each plot, resulting in a total of six pan traps of three different colors (yellow, blue, white) per site. The study identified seven dipteran families and 11 genera, the families with the highest frequencies were Caliphoridae, Muscidae and Stratiomyidae, respectively. Eight out of eleven (8/11) genera identified showed a significant difference between the wild and cultivated areas (P<0.05). Un-disturbed l and was favoured by dipteran pollinators; thus urging people to practice sustainable agriculture.

***Key words:*** *Abundance, Dipteran, Families, Habitat, Pollinators*



## 1. Introduction

*Lippia javanica* (umsuzwane/zumbani), a member of the Verbenaceae family, is a woody perennial herb or

* *Corresponding author: Nokubonga Ncube, Centre for Wildlife Conservation and Research, Gwanda State University, Epochmine Campus, P.O Box 30 Filabusi, Zimbabwe. E-mail: nokubongancube00@gmail.com*

shrub that grows up to 4.5 meters tall, characterised by creamy white flowers and lemon-scented leaves (Rodríguez-González *et al.*, 2020; Havens and Vitt, 2016). It belongs to a genus comprising approximately 32 genera and 840 species of tropical shrubs found worldwide (Kamanula *et al.*, 2017). The plant is adapted to various environments, including grasslands, riverine vegetation, woodlands, and disturbed areas (Maroyi, 2017). Flies, bees and other pollinators are attracted to plants' floral characteristics such as nectar availability, flower colors and scent (Dobson, 2017; Woodcock *et al.*, 2014; Shen *et al.*, 2024). Previous studies have documented *L. javanica's* medicinal and ecological importance (Bhebhe *et al.*, 2016); however, the pollination ecology of the plant remains understudied.

Worldwide, insect populations, including pollinators, are declining, and few studies have been conducted on dipteran pollinators (Orford *et al.*, 2015; Raguso, 2020). Diptera pollinators play a major role in ecosystem functioning, food production, biodiversity, and climate change adaptation (Ssymank *et al.*, 2008; Cook *et al.*, 2020). At the same time, due to anthropogenic activities and climate change, their distribution, richness, and seasonal activity are gradually changing, and hence they are becoming increasingly endangered (Banda *et al.*, 2021; Pecenka *et al.*, 2021). Almost 90% of wild flowering plants depend on pollination by animals, and among the different types of animal pollinators are dipteran pollinators. Despite the significant role played by the dipteran pollinators they are usually overlooked (Savino *et al.*, 2019). Understanding *L. javanica's* pollination allows for an in-depth understanding of the plant-pollinator interaction, which is crucial for informing conservation strategies and sustainable use, especially given its increased use, limited distribution, and increasing threats from overharvesting (Rodríguez-González *et al.*, 2020).

*Lippia javanica* emerged as one of the popular traditional medicinal plants, particularly during the COVID-19 pandemic, when it was harvested extensively for its medicinal benefits (Havens and Vitt, 2016; Early *et al.*, 2022). Studies by Osunsanmi *et al.* (2019) and Shode *et al.* (2023) found that *L. javanica* has phenolic compounds and essential oils which make the plant to have antioxidant, antimicrobial, and cognitive-enhancing properties. *L. javanica* essential oils, which contain high amounts of linalool and myrcene, have been used therapeutically for human health and wellbeing, such as for relieving stress, managing pain and fighting bacterial pathogens such as *Escherichia coli* and *Staphylococcus aureus* (Chagonda and Chalchat, 2015). *L. javanica* has been used in traditional medicine for coughs and colds, skin problems, and insect repellents, where leaves and stems are used for the preparation of herbal medicine (Bhebhe *et al.*, 2016; Pyenson, 2018). Overexploitation and habitat degradation lead to the loss of pollinators, which is a major threat to plant survival. This emphasises the importance of conserving species.

Dipteran pollinators, such as Syrphidae, Bombyliidae, and Calliphoridae make a very important contribution to pollination; however, their interactions with *L. javanica* are understudied (Marshall, 2012; Ojija *et al.*, 2026). Some flies serve as generalist pollinators for many plants, yet some have developed specialised morphological or behavioural traits to interact effectively with specific plants. This underscores their ecological importance and highlights the need for more detailed research to develop suitable conservation strategies (Loreau *et al.*, 2001). The knowledge gap of the role of diptera in pollination, particularly for plant species such as *L. javanica* impedes the conservation of these important pollinators as well as that of the plants dependent on them (Ssymank *et al.*, 2008; Maroyi, 2017). The decline in pollinator populations, the ecological and medicinal importance of *L. javanica* highlight the necessity for pollination ecology research of this plant species. Understanding composition and abundance of dipteran pollinators visiting *L. javanica* plays a vital role in the conservation of the plant as well as in the sustainable use of the plant. This study aims to fill this research gap by assessing the composition and abundance of dipteran flower visitors associated with *L. javanica* in cultivated and wild areas of Zimbiru and Mutake villages, Mashonaland East, Zimbabwe. This study compares pollinator communities in disturbed and undisturbed habitats. The study aims to guide conservation efforts and improve knowledge of the interactions between *L. javaniva* and dipteran pollinators, which are crucial for a resilient ecosystem and biodiversity preservation.

## 2. Materials and methods

### *2.1. Study area*

The study took place in Zimbiru and Mutake villages (around (17°37′ S to 17° 48′ S latitude and 31°10′ E to 31°

25′ E longitude), Domboshava, Goromonzi District, Mashonaland East, Zimbabwe, in Natural Farming Region II, which gets 700-800 mm of rainfall mainly in summer, supporting crops like maize and sorghum (Masona, 2016; Munyaka *et al.*, 2025). Temperatures range from 15 to 20 °C (Munyaka *et al.*, 2025). The region's vegetation consists of grasslands dominated by *Brachiaria* species and savannas with *Acacia* species, along with abundant *L. javanica* plants (Masona, 2016).

### 2.2. Study sites selection

The two villages, Zimbiru and Mutake were selected because of their proximity to each other and also a preliminary investigation that indicated a significant presence of *L. javanica* in both wild and cultivated areas was done before the study. Zimbiru, with its natural vegetation, served as a quasi-control site due to its undisturbed environment. In contrast, Mutake, which is primarily a cultivated area, functioned as the experimental (treatment) site. Despite differences in land use, the two village sites share broadly similar vegetation and climatic conditions. However, within each site, clear differences were observed between wild and cultivated areas. This combination made the villages suitable for the study, which encompassed both wild and cultivated environments.

### 2.3. Sampling design and trapping procedure

The research used a quasi-experimental design with three plot replicates for each of the experimental treatment and control. The plot design was used due to its simplicity of implementation and its capacity to minimise potential errors, such as variations in sun exposure, through a specific arrangement of plots. Moreover, this design enables repeated measurements over time, which improves data quality and reliability. In both cultivated (treatment) and wild (control) areas three 4 x 4 metre plots were set up, each plot having four bushes of *L. javanica*. To attract dipteran pollinators, three pairs of colored pan traps (white, blue and yellow) were utilised in each plot. These 15 cm x 15 cm pans were laid out in a single line in each plot and placed near the *L. javanica* plants so they are visible to pollinators.

### 2.4. Data collection

Data was collected during the hot/wet season between February-March 2024. Six pan traps per plot (two yellow, two blue, two white) were used to capture the dipteran pollinators visiting *L. javanica*. Filled with detergent to prevent escapes, traps were left for 12 hours daily over seven days per site. No additional olfactory attractant (e.g., scent or chemical lure) was added to the detergent solution, as the goal was to assess natural, visually-mediated attraction to floral-mimicking colors without introducing confounding olfactory cues that could bias visitation rates or species composition. The colors mimicked nearby flowers to influence visitation rates. The colors mimicked those of nearby flowers to influence visitation rates (Hegland and Totland, 2012; Arora and Sharma, 2017; Barron and Beston, 2022).

At day's end, pans were emptied into labelled containers with 80% isopropyl alcohol to preserve specimens. Taxonomy was conducted to the family and genus levels following the procedures and illustrations of Sinclair (2017). The identification was confirmed at the Bulawayo National Museum. Trap catches were recorded as the total number of dipteran flower visitors per plot per week at family and genus level.

### 2.5. Data analysis

Species composition was expressed as counts of respective genus and subsequently species. To assess the significant differences in species composition between the two habitats (cultivated vs wild areas), a Chi-Square test at 0.05 (5%) significance level was performed.

Relative abundance, calculated as the number of individuals trapped of a specific genus in a particular area divided by total number of individuals trapped in both areas, multiplied by 100. A Chi-Square was used to assess the significant differences in the relative abundance of dipteran pollinator genera between the cultivated and wild areas.

### 2.6. Ethical considerations

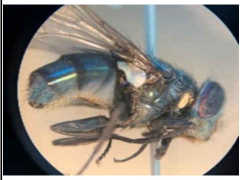
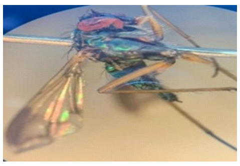
The researcher adhered to ethical standards by obtaining verbal consent from traditional leaders.

## 3. Results

### *3.1. Family composition of dipteran flower visitors and pollinators in cultivated and wild areas*

Seven (7) dipteran families were captured across the study sites (Table 1). The Calliphoridae had the highest

**Table 1: Composition and number of captured of dipteran flower visitor and potential pollinators**

| Family | Genus | Species | Number Trapped in Cultivated Area | Number Trapped in Wild Area | Total |
|---|---|---|---|---|---|
| Muscidae  | *Dimorphia* | *D. flavicornis* | 6 | 13 | 19 |
| | *Dichaetomyia* | *D. quadrata* | 3 | 8 | 11 |
| | Subtotal | | 9 | 21 | 30 |
| Calliphoridae  | *Pachychaeromyia* | *P. praegrandis* | 5 | 17 | 22 |
| | *Auchmeromyia* | *A. luteola* | 6 | 7 | 13 |
| | *Cordilobia* | *C.anthropophaga* | 3 | 15 | 18 |
| | Subtotal | | 14 | 39 | 53 |
| Stratiomyidae  | *Hermetia* | *H. illucens* | 2 | 14 | 16 |
| | *Ptecticus* | *P. posticus* | 0 | 6 | 6 |
| | Subtotal | | 2 | 20 | 22 |
| Chloropidae  | *Chlorops* | *C. cavicola* | 1 | 2 | 3 |
| Tachinidae  | *Hermyia* | *H. diabolus* | 1 | 2 | 3 |
| Dolichopodidae  | *Condylostylus* | *C. imitans* | 0 | 2 | 2 |
| Tephritidae  | *Spathulina* | *S. brevis* | 1 | 0 | 1 |
| Grand Total | | | 40 | 110 | 150 |

frequency, followed by Muscidae and then Stratiomyidae. Similarly, three species under the Caliphoridae family were identified, with the highest frequency also observed in the wild area. Within the Muscidae family, *Dimorphia flavicornis* and *Dichetomyia quadrata* were recorded, with the wild area showing the highest number of trapped pollinators (Table 1). Stratiomydae had two recorded species, with the wild area again showing the highest number of trapped pollinators. The following families had only one species recorded each: Chloropidae, Tachinidae, Dolichopodidae and Tephritidae. Notably, *Ptecticus posticus* and *Condylostylus imitans* were exclusive to the wild area, while *Spathulina brevis* was found only in the cultivated area. The wild area had the highest number of trapped pollinators compared to the cultivated area, indicating a preference for wild areas. However, the family composition of dipteran pollinators was highest in the cultivated area except for the Muscidae and the Stratiomyidae families (Table 1). The wild area, however, had a more diverse range of dipteran families as pollinators. A significant difference in diptera composition was only observed in the Stratiomyidae family (p = 0.034). No significant differences in diptera composition were observed in Muscidae (p = 0.453), Calliphoridae (p = 0.514), Chloropidae (p = 0.654), Tachinidae (p = 0.654), Dolichopodidae (p = 0.245) and Tephritidae (p = 0.122).

### *3.2. Dipteran genera relative abundance associated with L. javanica*

A total of 11 genera (Table 2) were recorded in both the wild and cultivated sites. The relative abundance in genera was highest in the wild areas as compared to the cultivated areas. There was a significant difference in the relative abundance of most genera, except in *Auchmeromyia* and *Hermyia*. The significant difference was mostly observed for the genera *Cordilobia*, *Hermetia*, *Ptecticus* and *Pachychaeromyia*.

**Table 2: Dipteran genera flower visitor and pollinator abundance visiting *L. javanica* recorded in the cultivated and wild areas**

| Genus | Number Recorded in Cultivated Area | Relative Abundance | Number Recorded in Wild Area | Relative Abundance | p-value |
|---|---|---|---|---|---|
| *Dimorphia* | 6 | 31.6 | 13 | 68.4 | 0.041* |
| *Dichaetomyia* | 3 | 27.2 | 8 | 72.7 | 0.013* |
| *Pachychaeromyia* | 5 | 22.7 | 17 | 77.2 | 0.002** |
| *Auchmeromyia* | 6 | 46.1 | 7 | 53.8 | 0.654 |
| *Cordilobia* | 3 | 16.6 | 15 | 83.3 | <0.001*** |
| *Hermetia* | 2 | 12.5 | 14 | 87.5 | <0.001*** |
| *Ptecticus* | 0 | 0 | 6 | 100 | <0.001*** |
| *Hermyia* | 1 | 33.3 | 2 | 66.6 | 0.245 |
| *Chlorops* | 1 | 33.3 | 2 | 66.6 | 0.245 |
| *Condylostylus* | 0 | 0 | 2 | 100 | 0.012* |
| *Spathulina* | 1 | 100 | 0 | 0 | 0.012* |

**Note:** P-value < 0.05 indicates a significant difference.

## 4. Discussion

The study provides valuable insights into the composition and abundance of dipteran flower visitors and potential pollinators in cultivated and wild areas. The composition of dipteran families between the two environments differed, however, with minor significant differences, highlighting the impact and role of habitat type in influencing pollinator composition. While abundance indicated major significant differences. The extent of forests and other natural habitats in a landscape influences the family composition of pollinators and flower visitors. The insignificance in family composition can be attributed to the study sites being in a similar agro-ecological region II, thus sharing broadly similar vegetation and climatic conditions. Environmental likeness has reliably been identified as a major driver of insect community composition because sites with similar climatic and vegetation characteristics tend to experience low species turnover and support comparable insect families (Chesters *et al.*, 2019). Likewise, studies in African agroecosystems have shown that where land-use systems and vegetation structure are broadly comparable, arthropod community composition often remains relatively stable regardless of disparities in ecosystem functioning (Birkhofer *et al.*, 2024). Therefore, the shared ecological features of the study sites likely contributed to the observed lack of significant discrepancy in insect family composition.

However, the lack of significant differences in family composition cannot be attributed exclusively to the shared agro-ecological region. Numerous studies have demonstrated that local-scale factors, including vegetation complexity, habitat heterogeneity, soil properties, agricultural management practices, and seasonal variation, can strongly influence insect community composition even within the same climatic region (Mhlanga *et al.*, 2022). For example, Mhlanga *et al.* (2022) found that ground insect assemblages varied significantly across land-use types within Zimbabwe despite similar regional climatic conditions, highlighting the importance of local habitat characteristics. Likewise, Mashavakure *et al.* (2019) informed that conservation agriculture practices such as residue retention and tillage significantly transformed beetle community composition in northern Zimbabwe. Consequently, the observed insignificant differences may also reflect limitations in sampling intensity, the use of family-level rather than species-level identification, or insufficient environmental heterogeneity among the sampled sites rather than the influence of agro-ecological similarity alone.

The wild area had abundant dipteran pollinators as compared to the cultivated area. This may be because the wild area is still in its natural state, with no use of chemicals; hence, the population of pollinator flies multiplies to high numbers. Conversely, the lower numbers of dipteran pollinators recorded in the cultivated area may be attributed to agrochemical use and habitat disturbance and destruction, resulting in a population reduction of dipteran pollinators. The findings imply that environmental factors such as habitat structure, food availability, and water sources can significantly influence dipteran populations. Most cultivated areas are disturbed and have limited resources due to agricultural practices and human land clearing thus, these places support fewer species of dipterans as compared to the wild areas, which have more diverse vegetation and stable ecosystems. The findings agree with previous studies, which also emphasised the significance of habitat heterogeneity for pollinator abundance (Potts *et al.*, 2010; Bommarco *et al.*, 2014). The reduction in nesting and foraging resources in cultivated areas is probably the reason for the decrease in dipteran composition and relative abundance (Aizen *et al.*, 2009). According to Neira *et al.* (2024), landscape and natural forest management systems can help ensure the continued availability of diverse pollinators and flower visitors in high numbers, thereby increasing resilience and the productivity of forestry and agriculture. The extent of forests and other natural habitats in a landscape influences the family composition of pollinators and flower visitors.

There were significant differences in most pairwise abundance comparisons among the genera between the two land-use types. The greater abundance of dipterans in wild areas might be due to richer food sources and diverse vegetation, which provide ample nectar and pollen, as well as to the fact that wild areas serve as suitable habitats for dipterans (Steffan-Dewenter and Tscharntke, 2019). Furthermore, the availability of water sources in both areas, such as perennial rivers in the wild area and dams in the cultivated area, ensured water wasn't a limiting factor in this study. On the other hand, there are other factors, such as flowering time, that might have an impact on dipteran populations. If pollinators emerge at different times from when the flowers bloom, as Hass *et al.* (2018) pointed out, it could have a negative effect on the pollinator community composition and relative abundance. Neira *et al.* (2024) suggest that habitat heterogeneity is an important factor in pollinator abundance. Thus, landscape composition is likely to have important effects on pollinator floral and nesting resources, and thus on their occurrence and abundance (Neira *et al.*, 2024). The loss of nesting and foraging resources for pollinators and flower visitors can reduce their composition and abundance.

In cultivated areas, habitat fragmentation due to agriculture and residential development increases isolation between patches, thereby worsening the decline of dipteran populations (Hailay Gebremariam *et al.*, 2024). The study therefore highlights the importance of using agricultural practices which balance ecological conservation with productivity.

## 5. Conclusion

The findings of the study indicated that the wild area had a slightly higher family composition and greater genera abundance of dipteran flies as compared to the cultivated area. Based on the study findings that dipteran flies genera prefer the wild area as compared to the cultivated areas farmers should prioritise conserving the wild areas by practising better agriculture methods such as leaving straps of undisturbed land between plots, reduction in use of harmful agrochemicals. This can in turn attract pollinators to cultivated areas. It is therefore imperative to introduce programs of monitoring and tracking dipteran populations and informing adaptive management, particularly in relation to habitat and agricultural changes. Further studies can assess the environmental factors that influence distribution of dipteran flies and their pollination roles to advise wildlife conservation efforts.

## Acknowledgment

We thank the Department of Biological Science and Ecology at the University of Zimbabwe, the village headman and the community for their support.

## References

Aizen, M.A., Garibaldi, L.A., Cunningham, S.A. and Klein, A.M. (2009). How much does agriculture depend on pollinators? Lessons from long-term trends in crop production. *Annals of Botany*, 103(9): 1579-1588. https://doi.org/10.1093/aob/mcp076

Arora, P.K. and Sharma, D.R. (2017). Management of insect pests in citrus. *Theory and Practice of Integrated Pest Management*, 377.

Banda, A., Madamba, D.C., Gumbo, T. and Chanyandura, A. (2021). Climate change extent and dipteran pollinators diversity in Africa. *Springer EBooks*, 1-20. https://doi.org/10.1007/978-3-030-22759-3_306-1

Barron, J. and Beston, J. (2022). Pollinator abundance and diversity under differing wet prairie management. *Natural Areas Journal*, 42(4). https://doi.org/10.3375/22-13

Bhebhe, M., Füller, T.N., Chipurura, B. and Muchuweti, M. (2016). Effect of solvent type on total phenolic content and free radical scavenging activity of black tea and herbal infusions. *Food Analytical Methods*, 9(4): 1060-1067. https://doi.org/10.1007/s12161-015-0270-z

Birkhofer, K., Bird, T., Alfeus, M., Arvidsson, F., Buxton, M., Djoudi, E.A., Fabiano, E., Kasinda, E., Machekano, H., Mpofu, P., Nghipunya, E.N., Segaiso, B.A. and Nyamukondiwa, C. (2024). Smallholder agriculture in African dryland agroecosystems has limited impact on trophic group composition, but affects arthropod provision of ecosystem services. *Agriculture, Ecosystems & Environment*, 363: 108860, ISSN 0167-8809. https://doi.org/10.1016/j.agee.2023.108860

Bommarco, R., Lindborg, R., Marini, L. and Öckinger, E. (2014). Extinction debt for plants and flower-visiting insects in landscapes with contrasting land use history. *Diversity and Distributions*, 20(5): 591-599. https://doi.org/10.1111/ddi.12187

Chagonda, L.S. and Chalchat, J.C. (2015). Essential oil composition of *Lippia javanica* (*Burm. f.*) spreng chemotype from Western Zimbabwe. *Journal of Essential Oil Bearing Plants*, 18(2): 482-485.

Chesters, D., Beckschäfer, P., Orr, M.C., Adamowicz, S.J., Chun, K.P. and Zhu, C.D. (2019). Climatic and vegetational drivers of insect beta diversity at the continental scale. *Ecology and Evolution*, 9(24): 13764-13775. https://doi.org/10.10002/ece3.5795

Cook, D.F., Voss, S.C., Finch, J.T.D., Rader, R.C., Cook, J.M. and Spurr, C.J. (2020). The role of flies as pollinators of horticultural crops: An Australian case study with worldwide relevance. *Insects*, 11(6): 341. https://doi.org/10.3390/insects11060341

Dobson, H.E. (2017). Floral volatiles in insect biology. *Insect-Plant Interactions (1993)*, 47-82.

Early, R., Rwomushana, I., Chipabika, G. and Day, R. (2022). Comparing, evaluating and combining statistical species distribution models and CLIMEX to forecast the distributions of emerging crop pests. *Pest Management Science*, 78: 671-683.

Hailay Gebremariam, G. (2024). A systematic review of insect decline and discovery: Trends, drivers, and conservation strategies over the past two decades. *Psyche: A Journal of Entomology*, 2024(1): 5998962.

Hass, A.L., Kormann, U.G., Tscharntke, T., Clough, Y., Baillod, A.B., Sirami, C., Fahrig, L., Martin, J.-L., Baudry, J., Bertrand, C., Bosch, J., Brotons, L., Burel, F., Georges, R., Giralt, D., Marcos-García, M.Á., Ricarte, A., Siriwardena, G. and Batáry, P. (2018). Landscape configurational heterogeneity by small-scale agriculture, not crop diversity, maintains pollinators and plant reproduction in western Europe. *Proceedings of the Royal Society B: Biological Sciences*, 285(1872): 20172242. https://doi.org/10.1098/rspb.2017.2242

Havens, K. and Vitt, P. (2016). The importance of phenological divesity in seed mixes for pollinator restoration. *Natural Areas Journal*, 23(8): 23-67.

Hegland, S.J. and Totland, Ø. (2012). Interactions for pollinator visitation and their consequences for reproduction in a plant community. *Acta Oecologica*, 43: 95-103. https://doi.org/10.1016/j.actao.2012.06.002

Hooper, N., Erdogan, A., Keen, G., Lawton, K. and McHugh, L. (2015). Perspective taking reduces the fundamental attribution error. *Journal of Contextual Behavioral Science*, 4(2): 69-72. https://doi.org/10.1016/j.jcbs.2015.02.002

Kamanula, J.F., Belmain, S.R., Hall, D.R., Farman, D.I., Goyder, D.J., Mvumi, B.M., Masumbu, F.F. and Stevenson, P.C. (2017). Chemical variation and insecticidal activity of *Lippia javanica* (*Burm. f.*) spreng essential oil against Sitophilus Zeamais Motschulsky. *Industrial Crops and Products*, 110: 75-82. https://doi.org/10.1016/j.indcrop.2017.06.036

Loreau, M., Naeem, S., Inchausti, P., Bengtsson, J., Grime, J., Hector, A., Hooper, D.U., Huston, M.A., Raffaelli, D., Schmid, B. and Tilman, D. (2001). Biodiversity and ecosystem functioning: Current knowledge and future challenges. *Science*, 294(5543): 804-808. https://doi.org/10.1126/science.1064088

Maroyi, A. (2017). Lippia javanica (*Burm.f.*) Spreng: Traditional and commercial uses and phytochemical and pharmacological significance in the African and Indian subcontinent. *Evidence-Based Complementary and Alternative Medicine*, Article 6746071. https://doi.org/10.1155/2017/6746071

Marshall, S.A. (2012). Flies, plants and fungi: Pollination, phytophagy, fungivory and decomposition. *In the Natural History and Diversity of Diptera*. 3560, Ontario, Canada.

Mashavakure, N., Mashingaidze, A.B., Musundire, R., Gandiwa, E., Thierfelder, C. and Muposhi, V.K. (2019). Beetle and maize yield response to plant residue application and manual weeding under two tillage systems in northern Zimbabwe. *Applied Soil Ecology*, 144: 139-146, ISSN 0929-1393. https://doi.org/10.1016/j.apsoil.2019.07.016

Masona, E. (2016). Land use/land cover changes and stakeholders: Investigating sustainable natural resources management options for an a1 farm a case study of essexdale farm in Marondera district, Zimbabwe.

Mhlanga, L., Kapembeza, C., Sithole, R. and Kativu, S. (2022). Variation in ground insect diversity, composition and abundance across land use types in an African savanna, Zimbabwe. *Scientific African*, 16: e01204. doi: https://doi.org/10.1016/j.sciaf.2022.e01204.

Munyaka, J.C.B., Gallay, O., Chenal, J., Mutandwa, E., Salgado, X., Pindayi, T., Gondo, D., Pfuma, H., Mhembere, R., Tamanikwa, T. and Chipise, S. (2025). Bridging the gender gap in climate-resilient sweet potato farming: A case study from Goromonzi District, Zimbabwe. *Systems*, 13(2): 135.

Neira, P., Blanco-Moreno, J.M., Olave, M., Caballero-López, B. amd Xavier Sans, F. (2024). Effects of agricultural landscape heterogeneity on pollinator visitation rates in Mediterranean oilseed rape. *Agriculture, Ecosystems & Environment*, 363: 108869-108869. doi: https://doi.org/10.1016/j.agee.2023.108869.

Ojija, F., Bacaro, G. and Mgimba, C. (2026). Contributions of dipterans to pollination services and biological control. *Entomologia Experimentalis et Applicata*, 1-11. doi: https://doi.org/10.1111/eea.70114.

Orford, K.A., Vaughan, I.P. and Memmott, J. (2015). The forgotten flies: The importance of non-syrphid diptera as pollinators. *Proceedings of the Royal Society B: Biological Sciences*, 282(1805): 20142934. https://doi.org/10.1098/rspb.2014.2934

Osunsanmi, F.O., Zharare, G.E. and Opoku, A.R. (2019). Phytochemical constituents and antioxidant potential of crude extracts from *Lippia javanica* (*Burm.f.*) spreng leaves. *Pharmacognosy Journal*, 11(4): 803-807. https://doi.org/10.5530/pj.2019.11.128

Pecenka, J.R., Ingwell, L.L. and Foster, R.E. (2021). Proceedings of the nation academy of sciences of United States of America. *Chicago: Academy of Sciences of United States of America*.

Potts, S.G., Biesmeijer, J.C., Kremen, C., Neumann, P., Schweiger, O. and Kunin, W.E. (2010). Global pollinator declines: Trends, impacts and drivers. *Trends in Ecology & Evolution*, 25(6): 345-353. https://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(10)00036-4?cc=y

Pyenson, N. (2018). Spying on whales: The past, present, and future of earth's most awesome creatures. *Viking Books*.

Raguso, R.A. (2020). Don't forget the flies: Dipteran diversity and its consequences for floral ecology and evolution. *Applied Entomology and Zoology*, 55: 17-45.

Rodríguez-González , A., Da Silver, F., Gutiérrez, S. and Casquero, P.A. (2020). *Lippia spp*. essential oil as a control agent against *Acanthoscelides obtectus*: An insect pest in *Phaseolus vulgaris* beans. *1st International Electronic Conference on Plant Science*, 1: 15.

Savino, V., Coviella, C.E. and Luna, M.G. (2019). Reproductive biology and functional response of dineulophus phtorimaeae: A natural enemy of the tomato moth. *Tuta absoluta*. *Journal of Insect Science*, 12(4): 153-179.

Shen, Y., Rao, Y., Ma, M., Li, Y., He, Y., Wang, Z., Liang, M. and Ning, G. (2024). Coordination among flower pigments, scents and pollinators in ornamental plants. *Horticulture Advances*, 2(1). https://doi.org/10.1007/s44281-024-00029-4

Shode, F., Sabiu, S., Aribisala, J. and Govender, K. (2023). An updated review (2015-2022) on the phytochemistry and pharmacological importance of *Lippia javanica* (*Burm. f.*) spreng. *Zenodo (CERN European Organization for Nuclear Research)*. https://doi.org/10.5281/zenodo.7880979

Sinclair, B.J. (2017). Manual of afrotropical Diptera: Introductory chapters and keys to Diptera families. South African National Biodiversity Institute.

Ssymank, A., Kearns, C.A., Pape, T. and Thompson, F.C. (2008). Pollinating flies (Diptera): A major contribution to plant diversity and agricultural production. *Biodiversity*, 9(1-2): 86-89. https://doi.org/10.1080/14888386.2008.9712892

Steffan-Dewenter, I. and Tscharntke, T. (2019). Effects of habitat isolation on pollinator communities and seed set. *Oecologia*, 121(3): 432-440. https://doi.org/10.1007/s004420050949

Stringer, C.B., Finlayson, J.C. and Barton, R. (2018). Neanderthal exploitation of Marine Mammals in Gibraltar. *Proc. National Academy of Science*, 105(3): 14319-14324.

Woodcock, T.S., Larson, B.M., Kevan, P.G., Inouye, D.W. and Lunau, K. (2014). Flies and flowers II: Floral attractants and rewards. *Journal of Pollination Ecology*, 12. https://doi.org/10.26786/1920-7603(2014)5

**Cite this article as:** Annabel Banda, Sarah Mukosa, James Machingura, Sija Amos Kabota, Edmore Utete and Nokubonga Ncube (2026). Taxonomic composition and abundance of dipteran flower visitors of *Lippia javanica* in cultivated versus wild areas of Mashonaland East, Zimbabwe. *African Research Journal of Biosciences*. 3(2), 28-36. doi: 10.62587/AFRJBS.3.2.2026.28-36.