DOI: https://doi.org/10.59983/s2024020304
AgroEnvironmental Sustainability, 2024, 2(3), 133-138

RESEARCH

Diversity and Relative Abundance of Insect Visitors of Litchi (*Litchi chinensis* Sonn.) at Baisjagar, Tanahun, Nepal

Nadima Karki [1,*] and Ishwar Prasad Kattel [1]

[1] Institute of Agriculture and Animal Science, Sundarbazar, Lamjung 33600, Nepal
[*] Author(s) responsible for correspondence; Email(s): nadimakarki50@gmail.com.

ARTICLE HISTORY
Received: 28 July 2024
Revised: 25 August 2024
Accepted: 29 August 2024
Published: 26 September 2024

KEYWORDS
Apis cerana
Diversity
Litchi pollinators
sticky trap

EDITOR
Pankaj Kumar

eISSN 2583-942X

Abstract

Litchi (*Litchi chinensis* Sonn.) is a highly cross-pollinated plant, and the identification of insect visitors is critical for enhancing its production. A study was conducted in Baisjagar, Tanahun, Nepal, from March to April 2023 to assess the diversity and relative abundance of insect visitors to Litchi trees. The experiment involved the use of yellow sticky traps placed on five different Litchi trees, with two traps installed per tree on branches near the panicles. Readings were taken weekly over four weeks. A total of eighteen insect species from six orders and thirteen families were identified during the study. Among the recorded insects, the order Diptera was the most abundant, accounting for 51.12% of the total, and was represented by five families: Syrphidae, Sarcophagidae, Calliphoridae, Muscidae, and Tachinidae. This was followed by Hymenoptera (32.02%), Hemiptera (12.54%), Lepidoptera (2.24%), Coleoptera (1.31%), and Orthoptera (0.74%). The species *Apis cerana* was the most frequently recorded, with 108 individuals captured. The study highlights the importance of pollinators, particularly Diptera and Hymenoptera, in Litchi production. Effective management and conservation of these pollinating insects can help ensure successful pollination and fruit production. Additionally, integrating apiculture with Litchi farming can enhance pollination services and provide mutual benefits, increasing yields and economic returns for farmers. This study suggested the need for sustainable practices to protect insect diversity in agricultural ecosystems.

Citation: Karki, N., & Kattel, I. P. (2024). Diversity and Relative Abundance of Insect Visitors of Litchi (*Litchi chinensis* Sonn.) at Baisjagar, Tanahun, Nepal. *AgroEnvironmental Sustainability*, 2(3), 133-138. https://doi.org/10.59983/s2024020304

Statement of Sustainability: The objectives of this research were to enhance the population of beneficial insects and to optimize Litchi production. The promotion of sustainable development can be significantly enhanced by the contribution of insects. However, the reduction in educational initiatives targeting these creatures is diminishing their impact. To meet the evolving demands of humanity for sustainable living, it is essential to re-examine the perspective and methodology of entomological literacy. The findings of this study lend support to the development of a more sustainable and resilient agricultural system that fosters a harmonious balance between human needs and natural preservation for future generations, following the sustainable development goals (SDGs).

1. Introduction

Litchi (*Litchi chinensis* Sonn., Sapindaceae) is regarded as one of the most popular subtropical evergreen Southeast Asian native tropical fruits. The Litchi fruit is enclosed by a white to cream-colored, translucent pulp, which is the edible part of the fruit. This is surrounded by a glossy brown seed. In terms of both area and production, Litchi occupies the fourth position in Nepal, trailing behind mango, banana, and mandarin (Saavedra et al., 2021). The country's primary Litchi cultivation region is Saptari, which encompasses a total area of 1,544 hectares, a productive area of 675 hectares, an annual fruit production of 6,413 metric tons, and a yield of 9.50 metric tons per hectare (MoALD, 2021). Litchi is a cross-pollinated tree that depends on insect pollination for fruit development due to the presence of self-sterility (Wahid et al., 2023). The Litchi panicle contains a substantial quantity of nectar, which attracts a variety of insects, including honeybees, ants, flies, and wasps. This leads to entomophilic cross-pollination. Honeybees collect pollen and nectar from the flower, thereby facilitating the pollination process (Hemalatha et al., 2018). Among the various insect visits to Litchi, honeybees have been identified as the most advantageous pollinators (Groff, 1943).

Flowering in Litchi occurs during the month of March-April, which attracts and invites several insects for pollination. The most common insect pollinators are syrphid flies (*Melanostoma univittatum* De Geer), honeybees (*Apis cerana* F., *A. dorsata* F., *A. mellifera* L., and *A. florea* F.), and twelve others. A total of 12 insect species were identified as visiting Litchi flowers in India. Of these, six were classified as belonging to the order Hymenoptera, five were assigned to the order Diptera, and one was placed in the order Coleoptera (Rai et al., 2017). As a cross-pollinated plant, Litchi requires a sufficient number of pollinating agents for successful pollination and fruit set. In terms of pollinating agents, insects are considered the most optimal choice in comparison to other methods of pollination, with the aim of achieving enhanced and beneficial results (Das et al., 2019). For cross-pollination to be successfully completed and fruit set to occur in Litchi, it is crucial to plan the abundance of insect pollinators in a strategic manner. This approach not only improves fruit production but also enhances fruit quality (Kumar, 2014).

While reports of beetles, bugs, moths, and flies visiting Litchi blooms have been documented, honeybees are frequently regarded as the primary pollinators. While honeybee pollination can significantly enhance Litchi production, yields are occasionally erratic and seldom attain the tree's full potential. This indicates that honeybees may be ineffectual in this context and/or that a substantial number of insect pollinators are essential (Stern and Gazit, 2010). Consequently, a comprehensive investigation was conducted to substantiate the diversity and relative abundance of insect visitors to Litchi flowers.

2. Materials and Methods

2.1. Research Site and Materials

The experiment was conducted at Baisjagar, Tanahun, Nepal (coordinates 28.07° N, 84.46° E, elevation 511 meters above sea level) (Figure 1) within a subtropical, temperate, and subalpine climate, with temperatures ranging between 30 and 41°C (Tripathi et al., 2020). The materials used for the experiments were yellow sticky traps, a sweep net, a microscope, ethyl acetate, and forceps.

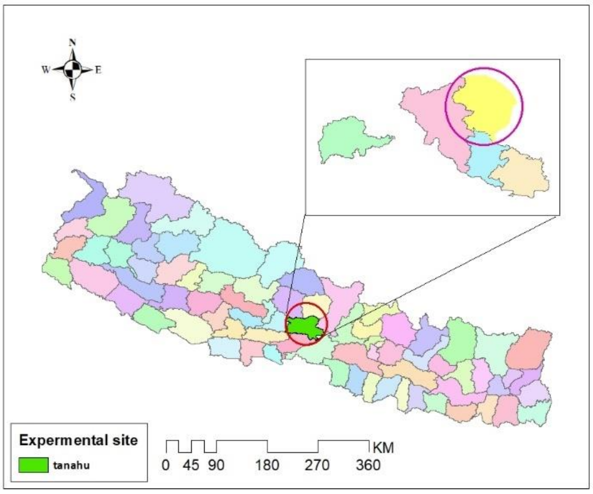

Figure 1. Geographical location of the experimental site.

2.2. Experimental Details

The experiment was conducted during the flowering stage of Litchi, which occurred between March and April of the year 2023. Pollinators were monitored using a combination of techniques, including the deployment of yellow sticky traps, the utilization of a sweep net, and visual observations. Five Litchi trees were randomly selected, and two sticky traps were installed in each tree. In each tree, the traps were positioned on a branch in proximity to the panicle, in two different directions, and were left for a period of one week. Each week, the sticky traps were removed, and the insects captured were collected and counted. This process was repeated for four weeks. Additionally, insects were collected using a sweep net and killed using ethyl acetate. These insects were preserved for identification purposes. To identify the insects, they were viewed under a microscope, and their identification was conducted with the assistance of a dichotomous key, in which insects were identified based on their body color, body patterns, and other characteristics.

2.3. Data Analysis

Data entry and analysis were done in MS Excel. The following formulae were used for calculation. Relative abundance was calculated by using the formula:

$$\left(\frac{n}{N}\right) \times 100$$

Where, n = number of each individual and N = total number of individuals. Similarly, the Shannon-Weiner Diversity Index was measured using the formula (Shannon, 1948):

$$H = -\sum Pi(\ln Pi)$$

Where, Pi = $\frac{ni}{N}$ (ni is the number of individuals of the species and N = $\sum \text{ni}$. Here, Low diversity=<1.5, Medium diversity=1.5<2.5, High diversity=>2.5.

3. Results and Discussions

3.1. Diversity and Relative Abundance of Insect Visitors

A total of 18 insect species belonging to six orders and 14 families of the class Insecta were recorded during the flowering period of Litchi (Table 1). A total of six species of insect belonging to five distinct families of Diptera were identified, namely: The families Syrphidae, Sarcophagidae, Calliphoridae, Muscidae, and Tachinidae. Similarly, three hymenopteran insects were identified as belonging to the Apidae and Vespidae families. The only family of Coleoptera caught in the trap was Coccinellidae, with two insects identified. Additionally, the Lepidopteran families were Nymphalidae, Erebidae, and Pieridae, with four insects identified that belonged to the aforementioned families. Finally, the families of Hemiptera and Orthoptera were Cicadellidae and Gryllidae, respectively, with three insects identified, one being Hemiptera and the other two Orthoptera. A similar study was conducted at the Agriculture and Forestry University (AFU) Rampur, Chitwan, during the Litchi flowering period (March to April 2019). In this study, a total of twenty-seven species of insects from six different orders and nineteen families were identified. The most prevalent species of pollinator on Litchi flowers were *A. dorsata* (30.63%), *A. mellifera* (9.46%), *A. florea* (6.76%), and *A. cerana* (3.60%) (Dubey et al., 2020). Similarly, the honeybee species *A. dorsata*, *A. mellifera*, *A. cerana*, and *A. florea* were the most significant and effective pollinators of Litchi flowers, comprising over 65% of the total pollinators. In addition to the Apis genus, other important pollinators included *Episyrphus balteatus*, *Melipona* sp., *Syrpus* sp., Erisyrphus sp., and so forth (Srivastava et al., 2017). The experiment conducted in the Litchi orchard of the Horticultural Research Station in the Nadia district of West Bengal revealed that a total of thirteen insect species from two different orders, namely Hymenoptera and Diptera, visited the Litchi flowers. Among Hymenopterans, *A. dorsata* (50.11%) was the predominant visitor, followed by *A. cerana indica* (11.80%), *A. florea* (8.68%), and *A. mellifera* (7.12%) (Das et al., 2019).

Table 1. Diversity and relative abundance of insect visitors of *L. chinensis* at Baisjagar, Tanahun.

Insect Visitors	Scientific Name	Family	Order	Number	Abundance (%)
Eupeodes	*Metasyrphus corollae*	Syrphidae	Diptera	41	7.678
Flesh fly	*Sarcophaga spp.*	Sarcophagidae	Diptera	57	10.674
Blowfly	*Calliphora spp.*	Calliphoridae	Diptera	32	5.992
Housefly	*Musca domestica*	Muscidae	Diptera	63	11.797
Marmalade hoverfly	*Episyrphus balteatus*	Syrphidae	Diptera	54	10.112
Tachinid fly	*Tachina ursina*	Tachinidae	Diptera	26	4.868
Paper wasp	*Polistes spp.*	Vespidae	Hymenoptera	46	8.614
Asiatic honeybee	*Apis cerana*	Apidae	Hymenoptera	108	20.224
Lesser paper wasp	*Parapolybia varia*	Vespidae	Hymenoptera	17	3.183
Ladybird beetle	*Menochilus sexmaculatus*	Coccinellidae	Coleoptera	2	0.374
Ladybird beetle	*Coccinella spp.*	Coccinellidae	Coleoptera	5	0.936
Monarch butterfly	*Danaus plexippus*	Nymphalidae	Lepidoptera	1	0.187
Sandalwood defoliator	*Amata passalis*	Erebidae	Lepidoptera	5	0.936
Cabbage butterfly	*Pieris brassicae*	Pieridae	Lepidoptera	5	0.936
Peninsular jester	*Symbrenthia lilaea*	Nymphalidae	Lepidoptera	1	0.187
Orange sharpshooter	*Bothrogonia addita*	Cicadellidae	Hemiptera	67	12.546
Green tree cricket	*Truljalia hibinonis*	Gryllidae	Orthoptera	1	0.187
Snowy tree cricket	*Oecanthus fultoni*	Gryllidae	Orthoptera	3	0.561

3.2. Number of Insects Trapped Respective to Orders After Trap Installation

The most prevalent order among the observed insects was Diptera, which accounted for a total of 273 insects. The second most prevalent order was Hymenoptera, with a total of 171 insects identified (Figure 2). A single insect from the Hemiptera order was identified, representing a total of 67 specimens. The prevalence of Diptera in our research may be attributed to the tropical climate of the study area. In tropical regions, the diversity of Diptera can exceed that of Hymenoptera (Inouye, 2011). Additionally, Diptera is one of the three largest and most diverse animal kingdoms, with nearly all ecosystems and biomes hosting members of this group. Pollination flies play a crucial role in the reproduction of numerous edible, ornamental, and medicinal plants, ensuring or enhancing seed and fruit production (Ssymank et al., 2011). The remaining orders, Lepidoptera, Coleoptera, and Orthoptera, were present in relatively low numbers, with 12, 7, and 4 specimens, respectively. The research conducted in Himachal Pradesh revealed the presence of 75 insect visitors belonging to the Hymenoptera, Lepidoptera, Diptera, and Coleoptera orders in the Litchi ecosystem (Kumari et al., 2023). Another experiment conducted in three localities of Haripur, Pakistan, from mid-March to mid-May 2012 yielded 494 collected insects, representing 20 species under 16 genera of eight families. These findings were classified under orders Diptera and Hymenoptera. The families Calliphoridae, Muscidae, Sarcophagidae, and Syrphidae were identified as belonging to the order Diptera, while the families Andrenidae, Apidae, Halictidae, and Vespidae were identified as belonging to the order Hymenoptera (Ali et al., 2013).

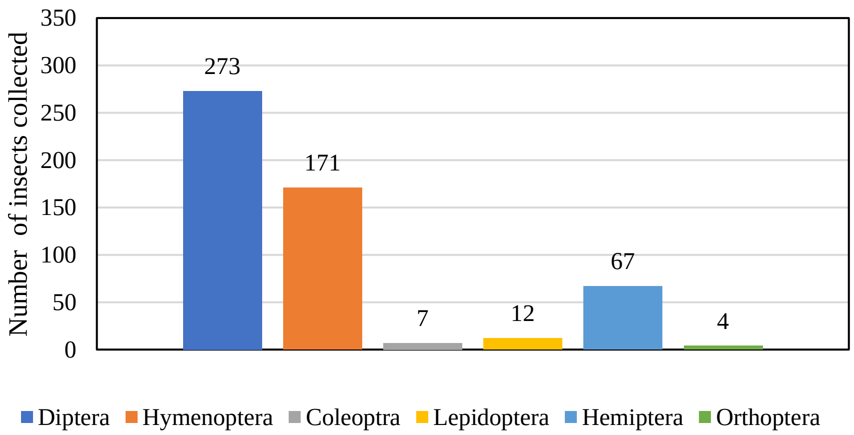

Figure 2. The number of insects trapped respectively to their orders after trap installation.

3.3. Number of Insects Trapped Respective to Days After Trap Installation

The trap was initially installed on March 14, and the reading was taken one week later (Figure 3). The process was repeated four times, with readings taken on the following dates: March 21 (first reading), March 28 (second reading), April 4 (third reading), and April 11 (fourth and final reading). The highest number of insects was collected during the second reading (March 28), namely 232. This was due to the fact that this was the peak flowering stage of the Litchi tree at Baisjagar. The second-highest reading was taken during the initial reading (March 14), which yielded 171 collected insects. The number of insects collected during the third and fourth readings (April 4 and April 11, respectively) were 84 and 47, respectively. This significant reduction can be attributed to the tree's onset of fruit set, which led to a decline in insect visitation and, consequently, a reduction in the number of insects caught in the sticky trap.

3.4. Diversity Index

The diversity of insect visitors to Litchi trees during the flowering period was quantified using the Shannon-Wiener Diversity Index (Table 2). The diversity index of the insects visiting the Litchi trees during the flowering stage was 1.12, which is less than 1.5. The findings indicated a relatively low diversity of insect visitors. The presence of certain species in high numbers during the flowering period at Baisjagar, Tanahun, may be a contributing factor. The research conducted on Litchi trees in Rampur, Chitwan, from March to April 2019 also demonstrated a lower diversity of insect visitors, as evidenced by a diversity index of 1.07 (Dubey et al., 2020), which is below the threshold of 1.5. Similarly, a study conducted in Muzaffarpur, Bihar, India, demonstrated a Shannon-Wiener diversity index of 2.33, indicative of moderate diversity (Wahid and Singh, 2024).

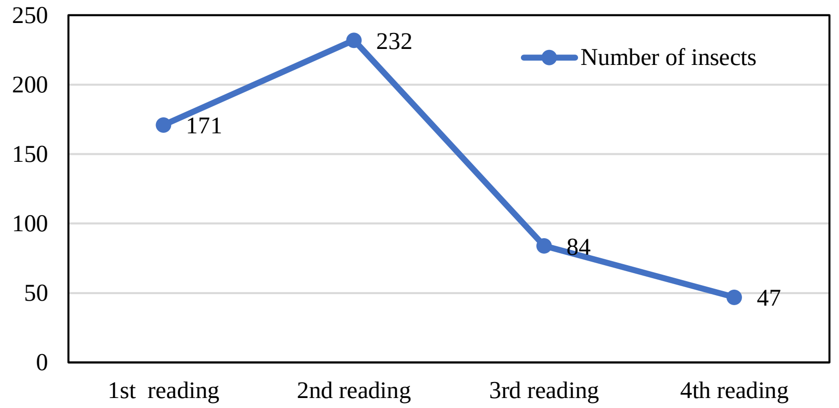

Figure 3. The number of insects trapped respectively to the reading after trap installation.

Table 2. Shannon-Wiener diversity index of insect visitors of *L. chinensis* at Baisjagar, Tanahun.

Insect Order	Species	Total Number of Insects	Diversity Index
Diptera	6	273	0.34
Hymenoptera	3	171	0.36
Coleoptera	2	7	0.05
Lepidoptera	4	12	0.08
Hemiptera	1	67	0.26
Orthoptera	2	4	0.03
Total	18	534	1.12

4. Conclusion

A total of 18 insect species were identified among the insects captured in the yellow sticky trap deployed on the Litchi tree in Baisjagar, Tanahun. The insects were identified as belonging to six different orders: Diptera, Hymenoptera, Coleoptera, Lepidoptera, Hemiptera, and Orthoptera. Similarly, thirteen families belonging to six different orders were identified, including Syrphidae, Sarcophagidae, Calliphoridae, Muscidae, Tachinidae, Vespidae, Apidae, Coccinellidae, Nymphalidae, Erebidae, Pieridae, and Cicadellidae. Additionally, Gryllidae were also observed. The most prevalent order among the identified insects was Diptera, followed by Hymenoptera. The Apidae family was the most abundant, and *A. cerana* was the most dominant species, with a relative abundance of 20.224%. The diversity index was determined to be 1.12, which is less than 1.5. It can thus be concluded that the diversity index is low. Consequently, the most effective measure for improving Litchi production would be to adopt apiculture and Litchi farming in conjunction. Furthermore, the conservation of the habitat of wild pollinators would also be beneficial for Litchi farming. To achieve this, it is essential to reduce forest fires and deforestation. Similarly, afforestation should be practiced to conserve and increase the habitat of wild pollinators.

Author Contributions: Conceptualization: Nadima Karki, Ishwar Prasad Kattel; Data curation: Nadima Karki, Ishwar Prasad Kattel; Funding acquisition: Nadima Karki, Ishwar Prasad Kattel; Investigation: Nadima Karki, Ishwar Prasad Kattel; Methodology: Nadima Karki, Ishwar Prasad Kattel; Resources: Nadima Karki, Ishwar Prasad Kattel; Software: Nadima Karki, Ishwar Prasad Kattel; Supervision: Nadima Karki, Ishwar Prasad Kattel; Validation: Nadima Karki, Ishwar Prasad Kattel; Visualization: Nadima Karki, Ishwar Prasad Kattel; Writing-original draft: Nadima Karki, Ishwar Prasad Kattel; Writing-review and editing: Nadima Karki, Ishwar Prasad Kattel. All authors have read and agreed to the published version of the manuscript.

Funding: This study did not receive project funding or external financial support.

Acknowledgment: The authors thank the Department of Horticulture and Plant Protection, Institute of Agriculture and Animal Science, Lamjung for their support in this research.

Conflicts of Interest: The authors declare no conflict of interest.

Institutional/Ethical Approval: Not applicable.

Data Availability/Sharing: The authors confirm that the data supporting the findings of this study are available within the article (and/or) its supplementary materials.

Supplementary Information Availability: Not applicable.

References

Ali, S., Shehzad, A., Rafi, M. A., & Zia, A. (2013). Insect Pollinators of Litchi (*Litchi chinensis Sonn*) From District Haripur, Pakistan. *Pakistan Journal of Agricultural Research,* 26(3), 220–230.

Das, R., Jha, S., & Halder, A. (2019). Insect pollinators of Litchi with special reference to foraging behaviour of honey bees. *Journal of Pharmacognosy and Phytochemistry*, 8(4): 396-401.

Dubey, D., Thapa, R. B., Tiwari, S., Gautam, B., & Sapkota, P. (2020). Diversity , Relative Abundance , and Diurnal Variation of Insect Visitors of Litchi (*Litchi chinensis* Sonn .) at Rampur , Chitwan , Nepal. *Entomology, Ornithology & Herpetology: Current Research*, 9(2), 1000226. https://doi.org/10.35248/2161-0983.20.9.226

Groff, G. W. (1943). Some ecological factors involved in successful lychee culture. *Proceedings of the Annual Meeting of the Florida State Horticultural Society*, 56, 134–155.

Hemalatha, D., Jayaraj, J., Murugan, M., Balamohan, T. N., Senthil, N., Chinniah, C., & Suresh, K. (2018). Floral Diversity for Foraging of the Asiatic Honey Bee, *Apis cerana indica* (Hymenoptera: Apidae) in Madurai District of Tamil Nadu, India. *International Journal of Current Microbiology and Applied Sciences*, 7(10), 3452–3456. https://doi.org/10.20546/ijcmas.2018.710.400

Inouye, D. (2011). Pollinators, the role of. In Encyclopedia of Biodiversity. https://doi.org/10.1016/B978-0-12-384719-5.00112-X

Kumar, R. (2014). Planned honey bee pollination in Litchi (*Litchi chinensis* Sonn.) - A new production strategy for enhancing fruit yield and quality in India. *Acta Horticulturae*, 1029, 281–286. https://doi.org/10.17660/ActaHortic.2014.1029.34

Kumari, P., Rana, S., & Bhargava, B. (2023). Diversity , Abundance and Impact of Insect Visitors in *Litchi chinensis* Production. pp. 1–10.

MoALD, 2021. (2021). Statistical Information On Nepalese Agriculture (2077/78). Publicatons of the Nepal in Data Portal, 73, 274. Available online: https://nepalindata.com/resource/statistical-information-nepalese-agriculture-207374-201617/ (accessed on 10 June 2024).

Rai, V. L., Srivastava, P., Bisht, K., & Mishra, V. K. (2017). Diversity and relative abundance of pollinating insects visiting Litchi (*Litchi chinensis* Sonn.) inflorescence under Tarai agro-climatic condition. *Journal of Experimental Zoology*, 20(1), 233–239.

Saavedra, Y., Shrestha, S., & Tichar, T. (2021). Scoping study on fruits and vegetables: results from Nepal. Technical Report: Wageningen University & Research.

Shannon, C. E. (1948). A Mathematical Theory of Communication. *Bell System Technical Journal*, 27(3), 379–423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x

Srivastava, K., Sharma, D., Pandey, S. D., Anal, A. K. D., & Nath, V. (2017). Dynamics of climate and pollinator species influencing Litchi (*Litchi chinensis*) in India. *Indian Journal of Agricultural Sciences*, 87(2), 266–269. https://doi.org/10.56093/ijas.v87i2.67663

Ssymank, A., Kearns, C. A., Pape, T., & 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

Stern, R. A., & Gazit, S. (2010). The Reproductive Biology of the Lychee. In Horticultural Reviews (Issue July 2010). https://doi.org/10.1002/9780470650851.ch8

Tripathi, S., Subedi, R., & Adhikari, H. (2020). Forest cover change pattern after the intervention of community forestry management system in the mid-hill of Nepal: A case study. *Remote Sensing*, 12(17), 2756.

Wahid, F., & Singh, B. K. P. (2024). Diversity and relative abundance of insect visitors to Litchi inflorescence with special reference to the foraging behaviour of honeybee (*Apis mellifera* L.). *Entomon*, 49(1), 135–140. https://doi.org/10.33307/entomon.v49i1.1048

Wahid, F., Singh, B. K. P., & Singh, S. N. (2023). Pollination efficacy of honeybee (Apis mellifera) influencing Litchi fruit production. *Journal of Pharmacognosy and Phytochemistry*, 12(5), 108–111. https://doi.org/10.22271/phyto.2023.v12.i5b.14712