

Foraging Tactics and Dietary Habits of Red-vented Bulbul (*Pycnonotus cafer stanfordi* Deignan) and Their Impact on Fruit Crops: A Field Case Study

Neelakshi Verma

vermaneelakshi25@gmail.com

Nagaland University, HQRS Lumami

Khangpila Sangtam

Nagaland University, HQRS Lumami

Ramita Sougrakpam

Nagaland University, HQRS Lumami

Bendang Ao

Nagaland University, HQRS Lumami

Research Article

Keywords: red-vented bulbul, crop damage, foraging, invasive, roost

Posted Date: August 3rd, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-9828213/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Seasonal variation in avian foraging behaviour can significantly influence crop depredation in agro-ecosystems, yet quantitative assessments linking seasonality, dietary shifts, and crop damage remain limited. Field observations were conducted across seasons to examine roosting behaviour, daily foraging patterns, dietary intake, and crop damage to three economically important fruit crops: guava, papaya, and banana.

During the non-breeding season, bulbuls formed communal roosts and exhibited a bimodal foraging pattern, with activity peaks occurring 1–2 hours before sunrise and again during late afternoon. In contrast, during spring and summer, these patterns were disrupted, and birds foraged solitarily or in pairs in multiple short bouts, reflecting seasonal behavioural plasticity. Dietary analysis revealed a season-dependent shift between plant and animal food resources. Plant-based diets peaked at $79.14 \pm 1.69\%$ in February and declined to $56.73 \pm 2.30\%$ in August, whereas animal-based diets increased correspondingly, reaching $43.27 \pm 2.30\%$ in August. Insect consumption was significantly higher during the monsoon period (June–September) compared to other months.

Controlled field assessments demonstrated measurable economic impacts on fruit crops, with estimated damages of 6.79% in banana, 13.10% in papaya, and 17.67% in guava of total yield. The findings indicate that seasonal resource availability and physiological demands influence bulbul foraging strategies, which in turn determine the extent of crop depredation. This study provides empirical evidence linking avian behavioural ecology with seasonal crop loss, offering insights relevant to avian pest management and agro-ecosystem conservation strategies.

Introduction

Bird depredation is a major challenge in fruit production systems worldwide, as frugivorous birds feed on ripening fruits and significantly reduce crop yield and market quality (Yodha et al., 2024; Lindell et al., 2025). Food availability, species interactions, and predation pressure are key ecological factors influencing the survival and reproductive success of species in natural environments (Lofts and Murton, 1968; Perfito et al., 2004; Caro et al., 2005; Dawson, 2008; MacDougall-Shackleton et al., 2009; Griebeler et al., 2010; Khamcha et al., 2012; Lal et al., 2012; Bonter et al., 2013; Pienaar et al., 2013). In birds, the ability to efficiently locate and utilize food resources is particularly critical, as seasonal fluctuations in resource availability often require behavioural and physiological adjustments. Species inhabiting different latitudes, or occupying different habitats within similar latitudinal zones, may adopt distinct foraging strategies to balance starvation risks with predation threats (Chandola et al., 1983; Sailaja et al., 1988; Wingfield and Farner, 1993; Neelakshi et al., 2022).

Many bird species exhibit considerable flexibility in their feeding ecology and may exploit a wide spectrum of food resources to meet metabolic demands associated with seasonal changes and varying physiological states. Such adaptability often enables birds to utilize anthropogenic food resources, including agricultural crops and orchards. Consequently, several bird species frequently invade granaries, crop fields, and fruit orchards to supplement their dietary requirements, sometimes resulting in significant economic losses to farmers (Bhatt and Kumar, 2001; Thiabault et al., 2019; Chishty et al., 2021; Enos et al., 2021). Experimental exclusion studies have demonstrated that bird damage can be substantially reduced when birds are prevented from accessing fruit crops, indicating that avian feeding activity contributes significantly to fruit loss in orchards (Lindell et al., 2025).

Among these species, *Pycnonotus cafer* is recognized for its highly opportunistic feeding behaviour and ecological adaptability (Jhahhria, 2025). Due to its diverse diet and invasive tendencies, the species has been listed among the world's 100 worst invasive alien species by the International Union for Conservation of Nature – Invasive Species Specialist Group (ISSG) (Lowe et al., 2000; IUCN, 2020). Native to South and Southeast Asia, the red-vented bulbul has expanded its distribution beyond its natural range and has established populations in several regions including the

Arabian Peninsula (Qatar, Kuwait, United Arab Emirates, Bahrain, Oman), Polynesia (Samoa, Fiji, Niuafo'ou and Tongatapu), parts of the United States, and the European Union, where its population is reported to be increasing (del Hoyo et al., 2005; Shirihai and Svensson, 2018; Fishpool and Tobias, 2019; Nowakowski and Dulisz, 2019).

The species is further divided into several subspecies with uneven geographical distributions. One such subspecies, *Pycnonotus cafer stanfordi*, occurs in parts of north-eastern India (southern Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, and Tripura), as well as in Bangladesh, northern Myanmar, and southwestern China (ZSI, 2006). North-eastern India represents one of the most biologically diverse regions of the Indian subcontinent, supporting a rich assemblage of flora and fauna (Jain and Das, 2022). However, increasing anthropogenic pressures such as unregulated resource exploitation, shifting cultivation practices, and habitat fragmentation are leading to rapid biodiversity loss in the region, highlighting the need for detailed ecological investigations to support conservation and management strategies (Jain and Das, 2022).

Despite the ecological and economic significance of the red-vented bulbul, limited information is available on the seasonal dynamics of its foraging behaviour, dietary composition, and associated crop damage in agro-horticultural landscapes of northeastern India. Understanding these patterns is essential for evaluating the species' ecological role and its potential impact on agricultural productivity.

Therefore, the present study examines the foraging behaviour and feeding ecology of the red-vented bulbul (*Pycnonotus cafer stanfordi*) and assesses its role in causing economic damage to selected fruit crops in Lumami (26°N), Nagaland. By integrating observations of seasonal foraging behaviour, dietary composition, and fruit crop damage, the study aims to provide insights into ecological interactions between the *Pycnonotus cafer* and fruit-growing landscapes in northeastern India.

Red-vented bulbul is a sexually monomorphic passerine which belongs to the family Pycnonotidae. The family incorporates 138 species of bulbuls described under 27 genera. Genus *Pycnonotus* includes 47 species which are scattered in many parts of the world outside their native Asian ranges (del Hoyo et al, 2005; Thibault et al, 2018a, 2018b, 2019; Nowakowski and Dulisz, 2019).

Study Area

The present study was conducted at Lumami (26°N), Zunheboto district, Nagaland, India, within an approximately 150 ha area bordering the southern and south-western boundaries of Nagaland University campus (Plate 1). The study site comprises mixed vegetation including fruiting trees, shrubs and cultivated crops that provide suitable feeding grounds for the *Pycnonotus cafer*.

Plate 1. Map of Nagaland State showing the location of study site at Lumami

(shaded area pointed with arrow).

Materials and Methods

Foraging Behaviour

Foraging behaviour was recorded during four sampling periods representing different seasons (January, March, May and August). Observations were conducted for four consecutive days in each sampling month from 04:00 h to 18:00 h. Bird activity was monitored from bird hides and elevated observation points located approximately 30–40 m from the study

area, including rooftops of various buildings within the Nagaland University campus, such as the library building, Controller of Examinations Office, academic departments, and residential quarters.

Bird observations were assessed using a combination of the point count method (Ralph et al., 1995) and area searches. Point counts were conducted from fixed observation points, while supplementary area searches involving slow movement through vegetation were undertaken to document birds and foraging activities that were not readily detectable from stationary observation locations. At least two observers independently recorded bird abundance and feeding behaviour during each session, and observations were cross-validated at the end of each survey day.

Foraging activity and feeding patterns were observed using binoculars (Canon 60 × 60). Photographic documentation of behavioural events was carried out using a Canon EOS 700D DSLR camera.

Gut Content Analysis

From January to December 2020, between the 11th and 15th day of each month, 4–6 freshly killed birds obtained from local hunters were collected for analysis. Immediately after collection, the body cavity was opened and the alimentary canal was carefully removed and preserved in 5% formalin solution.

On the following day, gut contents from individual birds were suspended in tap water and filtered through a 0.2 mm sieve. Unfiltered food particles were separated into watch glasses, dried on filter paper, and weighed using an electronic balance (Wensar Class II) with a precision (least count) of 100 mg. Dietary items were categorized into plant-based and invertebrate food resources, weighed separately, and preserved in 70% ethanol. Identification and examination of dietary components were performed using a dissecting microscope (Olympus SZ61) at 10× magnification.

All procedures involving wild birds were conducted with approval from the Institutional Animal Ethics Committee of Nagaland University (Approval No.: NU/Zoo/IAEC/Meeting No.01/2020/Protocol No.2).

Assessment of Crop Damage

To complement the dietary analysis, open-field experiment were conducted to evaluate the extent of crop damage caused by bulbuls to three fruit crops: *Musa acuminata* (Fig. 4A), *Carica papaya* (Fig. 4B), and *Psidium guajava* (Fig. 4C). Sixty plants each of banana (~ 1 year old) and papaya (~ 10 months old), and thirty plants of guava (~ 3 years old) were selected at the fruiting stage. In the first week of May 2021, thirty banana bunches and fruits from thirty papaya plants were protected using plastic nets, while the remaining thirty plants of each crop were left unprotected to allow bird access. Similarly, during the third week of October, before the onset of guava fruit ripening, fifteen guava plants were protected using thin plastic nets, while the remaining fifteen plants were left uncovered.

Banana bunches were harvested during the last week of June, whereas papaya fruits were harvested at the ripening stage between June and August. Guava fruits were harvested during the ripening period between October and December. All harvested fruits were categorized as intact, pecked, or damaged and packed separately. Marketable banana fingers were counted individually and their total yield was calculated. For papaya and guava, fruits from both protected and unprotected plants were weighed with a precision (least count) of 100 mg. The economic loss due to bird damage was estimated by comparing the market value of damaged fruits against the total gross yield, using prevailing local market prices per kilogram.

Figure 4A Banana crop damages

Fig 4B: Guava crop damages

Fig 4C: Papaya crop damages

Statistical Analysis

All data were analysed using one-way analysis of variance (ANOVA) and Student's t-test to determine differences among groups. Statistical significance was evaluated at a 95% confidence level ($p < 0.05$) following the procedures described by Snedecor (1961).

Results

Foraging Pattern

Foraging activity of the *Pycnonotus cafer* showed pronounced seasonal variation. During the non-breeding season, individuals exhibited consistent bimodal feeding peaks and strong reliance on communal roosts. Prior to flock dispersal, a distinctive roost-awakening behaviour was repeatedly observed, in which one or a few individuals initiated vocalizations before the synchronized departure of the group. This behaviour was absent or considerably reduced during the breeding season, when communal roosting broke down and foraging bouts became irregular.

Gut-content Analysis

Gut-content analysis revealed significant seasonal variation in dietary composition. Plant-based food resources constituted the major component of the diet throughout the year, although their relative proportion varied across months. Total intake and plant or invertebrate-based diets of birds are shown in Table 1.

Year 2020	Plant Food resource (g% ± SE)	Animal Food resource (g% ± SE)	Plant Food content (g ± SE)	Animal Food content (g ± SE)	Total Gut content (g ± SE)
January	74.70 ± 2.47	25.30 ± 2.47	3.93 ± 0.17	1.33 ± 0.14 ^e	5.26 ± 0.15
February	79.14 ± 1.69	20.86 ± 1.69	4.23 ± 0.32	1.03 ± 0.05 ^f	5.28 ± 1.37
March	77.36 ± 4.60	22.64 ± 4.60	3.60 ± 0.19	1.08 ± 0.23 ^d	4.68 ± 0.19
April	76.21 ± 3.38	23.79 ± 3.38	3.68 ± 0.16	1.15 ± 0.16 ^d	4.83 ± 0.09
May	72.82 ± 4.68	27.18 ± 4.68	3.25 ± 0.21	1.22 ± 0.22 ^d	4.47 ± 0.15
June	64.63 ± 4.52	35.37 ± 4.52	2.90 ± 0.17 ^b	1.60 ± 0.23	4.50 ± 0.11
July	58.29 ± 6.15	41.71 ± 6.15	2.50 ± 0.24 ^c	1.78 ± 0.17	4.28 ± 0.18
August	56.73 ± 2.30	43.27 ± 2.30	2.60 ± 0.15 ^c	1.98 ± 0.08	4.58 ± 0.09
September	66.34 ± 0.63	33.66 ± 0.63	3.30 ± 0.06 ^a	1.68 ± 0.10	4.98 ± 0.09
October	65.38 ± 2.98	34.62 ± 2.98	3.55 ± 0.21	1.85 ± 0.35	5.20 ± 0.14
November	74.43 ± 5.71	24.58 ± 5.71	3.75 ± 1.17	1.23 ± 0.28 ^d	4.98 ± 0.24
December	78.38 ± 4.93	21.65 ± 4.98	3.90 ± 0.27	1.03 ± 0.26 ^d	4.98 ± 0.09

Table – 1 Seasonal changes in Plant and animal food resources of wild red-vented bulbul, *Pycnonotus cafer stanfordi* Deignan at Lumami (26°N)*.

*Values are Mean ± SEM. n = 4 in each group. Total gut-contents across months, $F_{(11,36)} = 1.76$; Plant-based food resources in gut-contents across months, $F_{(11,36)} = 6.22$, $p < 0.0001$. Animal-based food resources in gut-contents across months, $F_{(11,36)} = 3.31$, $p < 0.001$ (ANOVA)

^{a,b,c} differ from the value of February at $p < 0.05$, < 0.01 and < 0.001 level respectively (Student's 't' test); ^{d,e,f} differ from August value at $p < 0.05$, < 0.01 and < 0.001 respectively (Student's 't' test).

Plant-based diet reached its maximum in February (79.14 ± 1.69%) and declined to its lowest level in August (56.73 ± 2.30%). Conversely, animal-based food resources showed an opposite trend, increasing during the monsoon period and reaching a maximum in August (43.27 ± 2.30%), while the minimum was recorded in February (20.86 ± 1.69%). Plant-based dietary components were significantly lower during June–September compared with February values (ANOVA, $p < 0.05$). In contrast, insect-based food items were significantly higher during August than during the November–May period ($p < 0.05$) (Fig. 1).

Assessment of Crop Damage

Given the substantial contribution of plant-based items, particularly fruits, to the seasonal diet described above, the extent to which bulbuls utilize cultivated fruit crops was quantified through the open-field experiment and No damage to fruit crops were seen in protected plants. Average of marketable banana fingers from protected and unprotected plants were 3,834 and 3,240 respectively. As assessed from peck-marks and damaged endocarps, 480 fingers were spoiled by red-vented bulbuls and 114 by animals like bats and squirrels. At the market rate of Rs 6/finger they were sold out for Rs 42,444. Total loss on account of 480 fingers damaged by red-vented bulbuls amounted to Rs. 2,880 which was 6.79%

(F1,58 = 12.24; $p < 0.05$) of the gross yield (Fig. 3A). A total of 114 fingers damaged by other animals made a loss of 1.61% of the gross yield.

Combined weight of marketable papaya fruits from protected (564 kg) and unprotected (411 kg) plants was 975 kg. At market rate of Rs 50/kg the stuff was sold of for Rs. 48,750. A total of 147 kg papaya fruits were damaged by birds which amounted to 15.08% of the gross yield (F1,58 = 24.60; $p < 0.05$) (Fig. 3B). Damages incurred through other animals was 72 kg, which amounted to 7.38% of the total yield.

Combined weight of intact guava fruits from protected (798 kg) and unprotected (516 kg) plants was 1,314 kg. At market rate of Rs. 40/kg they were sold out for Rs. 52,560. The loss due to non-marketable fruits amounted to Rs. 9,288 which made 17.67% of the gross yield (F1,28 = 14.58; $p < 0.05$) (Fig. 3C). Total damage by other animals was 66 kg which amounted to 5.02% of the gross yield.

A comparative assessment of crop yield, bird-associated fruit utilization, and corresponding economic estimates across fruit crops is presented in Table 2.

Table 2

Quantitative assessment of fruit utilization and yield variation across cultivated banana, papaya, and guava crops due to red-vented bulbul (*Pycnonotus cafer stanfordi*) and other animals in a tropical mosaic landscapes.

Crop	Protected Plants	Unprotected Plants	Total Yield	Market Rate	Total Sales	Damaged By	Amount of Damage	% of Gross Yield	Total Loss
Bananas	3834 Fingers	3240 Fingers	7074 Fingers	Rs 6/Finger	Rs 42,444	Red-vented Bulbuls	480 fingers	6.79%	Rs 2880
	Damage to Banana Crop by Other Animals (Bats, Squirrels)						114 fingers	1.61%	Rs 684
Papayas	564 kg	411 kg	975 kg	Rs 50/kg	Rs 48,750	Birds	147 kg	15.08%	Rs 7,350
	Damage to Papaya Crops by Other Animals						72 kg	7.38%	Rs 3,600
Guavas	798 kg	516 kg	1314 kg	Rs 40/kg	Rs 52,560	Non-marketable fruits	232.2 kg	17.67%	Rs 9288
	Damage to Guava Crop by Other Animals						66 kg	5.02%	Rs 2640

Discussion

Foraging Behaviour

During the non-breeding season (January and March), birds exhibited a bimodal pattern of foraging, with the first peak occurring approximately one hour before sunrise and continuing for 2–3 h, followed by a second peak 3–4 h before sunset. Birds were generally observed foraging in groups after dispersing from communal roosts (Fig. 2). Dispersal for foraging during the non-breeding season was preceded by a distinct "roost-awakening" phase characterized by acoustic signals produced by a small group of individuals within the colony. Delays in roost dispersal were occasionally observed during periods of heavy rainfall, strong winds, and low winter temperatures, indicating that adverse weather conditions

may temporarily suppress early morning feeding activity. During spring and summer (May and August), the bimodal foraging pattern changed noticeably. Birds were frequently observed foraging singly or in pairs, and feeding activity occurred in multiple shorter bouts throughout the day rather than in two distinct peaks.

Fruit Crop Damage

The seasonal changes in foraging schedules described above were accompanied by corresponding shifts in the composition of the diet itself. Analysis of gut contents revealed that the red-vented bulbul maintains an omnivorous feeding strategy, consuming both plant- and animal-derived food resources throughout the year. This dietary flexibility is consistent with previous studies describing the species as a highly opportunistic feeder capable of exploiting a wide range of resources including Nectar from Indian coral trees (Fig. 5) (Bhatt and Kumar, 2001; del Hoyo et al., 2005; Thibault et al., 2019; Nowakowski and Dulisz, 2019; Chishty et al., 2021; Zohaib et al., 2021).

Despite relatively stable total food intake across seasons, pronounced shifts occurred in the relative contribution of plant- and animal-based food items. Plant-derived resources increased gradually from November to February and declined thereafter, whereas animal-derived food items exhibited an opposite seasonal trend. Such reciprocal patterns indicate seasonally regulated dietary switching, likely driven by fluctuations in food availability and changes in physiological demands.

During the winter months (November–February), plant-based diets were dominated by fruits, nectar, flower buds, and seeds, whereas animal-derived food consisted primarily of ants and honey bees. Between March and May, birds expanded their diet to include berries, cherries, floral resources, and a variety of insects, including grasshoppers, aphids, thrips, and termites. From June to October, dietary preference shifted markedly toward invertebrate-rich diets, including spiders, grasshoppers, ants, and winged termites. During this period birds were frequently observed capturing aerial insects at considerable heights above the ground, occasionally competing with swallows and other insectivorous birds. The increased consumption of invertebrates during this period may reflect elevated energetic demands associated with the transition from breeding to non-breeding phases, when birds must replenish energy reserves depleted during reproduction and feather moult (Neelakshi, 2022).

Seasonal variation in plant- and animal-based diets exceeded 70% and 115% of baseline consumption, respectively, indicating strong metabolic drivers influencing dietary preferences. When insect availability declined during late autumn and winter, birds increased their reliance on nectar from *Butea monosperma*, *Bombax ceiba*, *Hibiscus rosa-sinensis*. During nectar collection, bulbuls frequently synchronized visits to flowering trees with honey bees and occasionally ingested hymenopterans. Similar interactions between bulbuls and flowering trees such as *Erythrina variegata* and *Erythrina indica* have previously been reported (Raju et al., 2004).

Interestingly, no evidence was found of reptiles such as *Hemidactylus flaviviridis* or *Hemidactylus frenatus* in the gut contents examined. This contrasts with earlier reports suggesting occasional reptile predation by bulbuls (Sharma, 2000; Nowakowski and Dulisz, 2019; Thibault et al., 2019). The absence of such prey items may reflect habitat preferences of the subspecies *Pycnonotus cafer stanfordi*, which was rarely observed in close association with human dwellings where these reptiles commonly occur.

This pronounced dietary flexibility, while ecologically advantageous to the species, has wider implications for the agro-ecosystems in which bulbuls forage. The feeding ecology of bulbuls generates both ecological benefits and economic costs within agro-ecosystems. Positive ecological roles include pollination during nectar foraging activity and the dispersal of seeds from numerous fruiting plants, thereby contributing to vegetation regeneration and landscape connectivity. Additionally, the consumption of insect larvae may provide indirect pest control benefits. However, the same feeding flexibility can also generate negative impacts. Bulbuls may disperse invasive plant species such as

lantana and Mexican sunflower, and their consumption of pollinating insects may affect pollinator populations. More importantly, direct feeding on commercial fruit crops can lead to measurable economic losses.

The present open-field experiment demonstrated substantial damage to three economically important fruit crops: *Psidium guajava*, *Carica papaya*, and *Musa acuminata*. Estimated losses reached 17.67% in guava, 15.08% in papaya, and 6.79% in banana of total yield. These findings are consistent with previous studies documenting significant crop damage caused by bulbuls in agricultural landscapes (Bhatt and Kumar, 2001; Thibault et al., 2019). Observations also indicated that ripe fruits and insect larvae constituted important food resources for fledglings and breeding adults, particularly during the breeding season. During winter months, when natural food resources were comparatively limited, birds frequently consumed the pericarp and thalamus of guava fruits. These patterns suggest that seasonal variation in crop damage may be closely linked to changes in resource availability and breeding-related nutritional demands.

Taken together, the findings of this study reveal a tightly integrated picture of the red-vented bulbul's ecology at Lumami. Seasonal shifts in foraging schedules, transitions between group and solitary feeding, corresponding changes in plant- and animal-based dietary components, and the measurable damage inflicted on cultivated fruit crops are not independent phenomena but interlinked expressions of a single adaptive strategy. The seasonal plasticity in feeding ecology enables bulbuls to exploit fluctuating resource availability while meeting changing physiological demands throughout the annual cycle, and it is precisely this flexibility that underlies both their ecological success and their conflict with fruit-based agriculture in the region.

Conclusion

The present study provides new insights into the seasonal foraging ecology and crop-damage potential of the red-vented bulbul in northeastern India. Populations of *Pycnonotus cafer* at Lumami exhibited communal roosting during autumn and winter, with roosts being activated each morning by acoustic signals prior to coordinated dispersal. During the non-breeding season, birds displayed a bimodal foraging pattern, whereas breeding activities disrupted roost structure and resulted in more irregular feeding bouts.

Dietary analysis revealed strong seasonal shifts in the relative consumption of plant- and animal-derived food resources, reflecting adaptive responses to changing environmental conditions and physiological demands. While plant-based foods dominated during winter months, invertebrate consumption increased markedly during the monsoon and post-breeding periods.

The opportunistic feeding behaviour of bulbuls also results in measurable economic losses to fruit crops, with damage levels reaching 6.79% in banana, 13.10% in papaya, and 17.67% in guava. These findings highlight the importance of understanding avian feeding ecology in agro-ecosystems and provide a scientific basis for developing integrated crop protection and bird-management strategies in fruit-growing regions.

Declarations

Ethical approval

All procedures involving animals were conducted in accordance with the guidelines of the Institutional Animal Ethics Committee of Nagaland University. The study was approved under protocol number NU/Zoo/IAEC/Meeting No.01/2020/Protocol No.2.

Data availability

The data supporting the findings of this study are available from the corresponding author upon request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Author contributions

Neelakshi Verma and Bendang Ao were responsible for the conceptualization and design of the study, data interpretation, and manuscript preparation. Khangpila Sangtam and Neelakshi Verma carried out the fieldwork. Ramita Sougrakpam, Neelakshi Verma, and Bendang Ao contributed to critical review and revision of the manuscript.

AI Declaration

The authors used an AI-assisted language tool for minor grammar and language editing. All scientific content, interpretation, and conclusions are the responsibility of the authors.

Funding

The authors received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

1. Bhatt, D., Kumar, A., 2001. Foraging ecology of red-vented bulbul, *Pycnonotus cafer* in Haridwar, India. Forktail 17, 109-110.
2. Bonter, D. N., Zuckerberg, B., Sedgwick, C. W., & Hochachka, W. M. (2013). Daily foraging patterns in free-living birds: Exploring the predation–starvation trade-off. *Proceedings of the Royal Society B: Biological Sciences*, 280(1760), 20123087. <https://doi.org/10.1098/rspb.2012.3087>
3. Caro, S.P., Balthazart, J., Thomas, D.W., Lacroix, A., Chastel, O., and Lambrechts, M.M. 2005. Endocrine correlates of the breeding asynchrony between two Corsican populations of blue tits (*Parus caeruleus*), *Gen. Comp. Endocrinol.* 140, 52-60.
4. Chandola, A., Bhatt, D. and Pathak, V.K. (1983). Environmental manipulation of seasonal reproduction in spotted munia, *Lonchura punctulata*. In 'Avian Endocrinology, Environmental and Ecological Perspectives' (S., Mikami, K., Homma and M., Wada, eds.), Japan Sci. Soc. Press, Tokyo/Springer-Verlag, Berlin, pp 229-242.
5. Chishty, N., Parveen, R., Choudhary, N. L., Patel, P., Kumawat, P., 2021. Food and feeding behaviour of red-vented bulbul (*Pycnonotus cafer*) and role in seed dispersal at urban area, Udaipur, Rajasthan, India, *Asian J. Biol. and Life Sci.* 10(1), 40.44.
6. Dawson, A., 2008. Control of the annual cycle in birds: endocrine constraints and plasticity in response to ecological variability, *Philos. Trans. R. Soc. Lond. B Biol. Sci.* 363(1497), 1621-1633.
7. del Hoyo, J., Elliot, A., Christie, D.A., 2005. Handbook of birds of the world, Vol. 10, Cuckoo-Shrikes to Thrushes, Lynx Edicions, Barcelona, 895pp.
8. Enos, J.K., Ward, M.P. and Hauber, M.E., 2021. A review of the scientific evidence on the impact of biologically salient frightening devices to protect crop from avian pests. *Crop Protection*. 148,105734.
9. Fishpool, L., Tobias, J., 2019. Red-vented Bulbul (*Pycnonotus cafer*). In *Handbook of the birds of the World alive*, (J. del Hoyo, A. Elliot, J. Sargatal, D. A. Christie and E. de Juana, eds.). Lynx Edicions, Barcelona.
10. Griebeler, E.M., Caprano, T. and Bohning-Gase, K., 2010. Evolution of avian clutch size along latitudinal gradients: do seasonality, nest predation or breeding season length matter?, *J. Evol. Biol.* 23(5): 88-901. <https://doi.org/10.1111/j.1420-9101.2010.01958.x>

11. IUCN, 2020. Birds Life International 2020. *Pycnonotus cafer*. The IUCN red list of threatened species 2020.
12. Jain, A., and Das, A., 2022. North-East India: A unique biodiversity paradise unexplored or lost?. *Int. J. Sci. and Res. Publ.* 2(40), 1-8.
13. Jhahhria, A. (2025). *Ecological study of red-vented bulbul in the campus environment of Government College Gudha Jhunjhunu*. *International Journal of Fauna and Biological Studies*, 12(3), 29–33.
<https://doi.org/10.22271/23940522.2025.v12.i3a.1099>
14. Khamcha, D., Savini, T., Brockleman, W.Y., Chimchome, V. and Gale, G.A., 2012. Influence of food availability and distribution on the movement patterns of a forest avian frugivore, the Puffed-throated bulbul (*Alophoixus pallidus*), *J. Trop. Ecol.* 28, 1-9. <https://doi.org/10.1017/S026646741100054X>
15. Lal, P., Lalmuoklien and Bendang, Ao., 2012. Breeding Biology of Spotted Munia, *Lonchura punctulata* in the Imphal valley. *NU Research Communication (R.C., Gupta, ed.)*, Cambridge University Press India Pvt. Ltd., pp 153-170.
16. Lofts, B., and Murton, R.K., 1968. Photoperiodic and physiological adaptations regarding avian breeding cycles and their ecological significance, *J. Zool. Lond.* 155, 327-394. <https://doi.org/10.1111/j.1469-7998.1968.tb03056.x>
17. MacDougall-Shackleton, S.A., Stevenson, T.J., Watts, H.E., Pereyra, M.E. and Hahn, T.P., 2009. The evolution of photoperiod response system and seasonal GnRH plasticity in birds, *Integr. Comp. Biol.* 49(5), 580-589.
<https://doi.org/10.1093/icb/icp048>
18. Lindell, C. A., Rothwell, N. L., Collino, S., & Powers, K. (2025). Netting reduces bird damage and spotted wing Drosophila in high-density sweet cherries with few effects on fruit quality. *Crop Protection*, 195, 107239.
<https://doi.org/10.1016/j.cropro.2025.107239>
19. Lowe, S., Browne, M., Boudjelas, S., De Poorter, M., 2000. 100 of the World's worst invasive species: A selection from the Global Invasive species Database, (PDF), The Invasive species specialist group (ISSG).
20. Neelakshi, V., 2022. Environmental correlates of reproductive functions in red-vented bulbul, (*Pycnonotus cafer stanfordi* Deignan) in Lumami, Zunheboto district, Nagaland. Ph.D. Dissertation, Nagaland University.
21. Neelakshi, V., Lalmuoklien and Lal, P., 2022. Nesting ecology, territoriality and brood care in red-vented bulbul, *Pycnonotus cafer stanfordi* Deignan at Lumami, Zunheboto district, Nagaland, *UPJOZ*, 43(24), 668-679.
22. Nowakowski, J., & Dulisz, B. (2019). The Red-vented Bulbul *Pycnonotus cafer* (Linnaeus, 1766)-A new invasive bird species breeding in Europe. *BioInvasions Records*, 8(4), 947-952.
<https://doi.org/10.3391/bir.2019.8.4.24>
23. Perfito, N, Tramontin, A.D., Meddle, S., Sharp, P.J., Afik, D., Gee, J., Ishii, S., Kikuchi, M. and Wingfield, J.C., 2004. Reproductive development according to elevation in a seasonally breeding male song bird, *Oecologia*. 140, 201-210.
<https://doi.org/10.1007/s00442-004-1576-5>
24. Pienaar, J., Ilany, A., Geffen, E., & Yom-Tov, Y. (2013). Macroevolution of life-history traits in passerine birds: adaptation and phylogenetic inertia. *Ecology Letters*, 16(5), 571-576.
<https://doi.org/10.1111/ele.12077>
25. Raju, A.J.S., Rao, S.P., Zafar, R., Roopkalpana, P., 2004. Passerine bird pollination and fruiting behavior in *Erythrina variegata* L. (Fabaceae) in the eastern Ghats, India *Beitr. Biol. Pflanzen*. 73, 321-330.
26. Ralph, C. J., Geupel, G. R., Pyle, P., Martin, T. E., & DeSante, D. F. (1993). *Handbook of field methods for monitoring landbirds* (General Technical Report PSW-GTR-144). U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. <https://doi.org/10.2737/PSW-GTR-144>
27. Ralph, C. J., Sauer, J. R., & Droege, S. (Eds.). (1995). *Monitoring bird populations by point counts* (General Technical Report PSW-GTR-149). U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.
<https://doi.org/10.2737/PSW-GTR-149>

28. Sailaja, R., Kotak, V.C., Sharp, P.J., Schmedemann, R. and Hasse, E., 1988. Environmental, dietary and hormonal factors in the regulation of seasonal breeding in free living female Indian rose-ringed parakeets, *Psittamikrameri*, *Horm. and Behav.*, 22, 518-527. [https://doi.org/10.1016/0018-506X\(88\)90055-4](https://doi.org/10.1016/0018-506X(88)90055-4)
29. Sharma, S. K. (2000). Redvented bulbul *Pycnonotus cafer* feeding on tail of house gecko *Hemidactylus flaviviridis*. *JOURNAL-BOMBAY NATURAL HISTORY SOCIETY*, 97(2), 284-284.
30. Shirihi, H., Svensson, L., 2018. Handbook of western Palearctic birds., Vol. 1. Passerines: Larksto Warblers, Helm. Bloomsbury Publ. Plc, London, UK, 648pp.
31. Snedecor, C.W., 1961. Statistical methods. Pacific Private Ltd., Bombay, India.
32. Thibault, M., Vidal, E., Potter, M. A., Dyer, E., & Brescia, F. (2018). The red-vented bulbul (*Pycnonotus cafer*): serious pest or understudied invader?. *Biological invasions*, 20(1), 121-136. <https://doi.org/10.1007/s10530-017-1521-2>
33. Thibault, M., Vidal, E., Potter, M. A., Sanchez, T., & Brescia, F. (2018). The invasive Red-vented bulbul (*Pycnonotus cafer*) outcompetes native birds in a tropical biodiversity hotspot. *PLOS one*, 13(2), e0192249. <https://doi.org/10.1371/journal.pone.0192249>
34. Thibault, M., Vidal, E., Potter, M.A., Masse, F., Pujapujane, A., Fogliani, B., Lannuzel, G., Jourdan, H., Robert, N., Demaret L., Barre, N., Brescia, F., 2019. Invasion by the red-vented bulbul: an overview of recent studies in New Caledonia. In (C.R., Veitch, M.N. Clout, A.R., Martin, J.C., Russel, and C.J., West, eds.), *Island invasives: scaling up to meet the challenge*. Occasional Paper SSC no. 62., Gland, Switzerland : IUCN, pp 309-316. <https://doi.org/10.2305/IUCN.CH.2019.SSC-OP.62.en>
35. Wingfield, J.C., and Farner, D.S., 1993. Endocrinology of reproduction in wild species. *Avian Biol.* 9, 163-327.
36. Yodha, K., Singh, D., Kour, A., Yadav, R., & Kumar, R. (2024). Birds damage to horticultural crops. In *Futuristic Trends in Agriculture Engineering & Food Sciences*. Iterative International Publishers. <https://doi.org/10.58532/V3BCAG22CH4>
37. Zohaib, M., Ansari, M. S., Rakha, B. A., & Akhter, A. (n.d.). Nesting and Breeding Success of Red-vented Bulbul (*Pycnonotus cafer*) in Orchards, Parks and Agricultural Fields in Renala Khurd, District Okara, Punjab, Pakistan. *Pakistan Journal of Zoology*, 54(1). <https://doi.org/10.17582/journal.pjz/20190718090729>
38. ZSI, 2006. Fauna of Nagaland. Publ. Zoological Survey of India, p522.

Plate

Plate 1 is available in the Supplementary Files section.

Figures

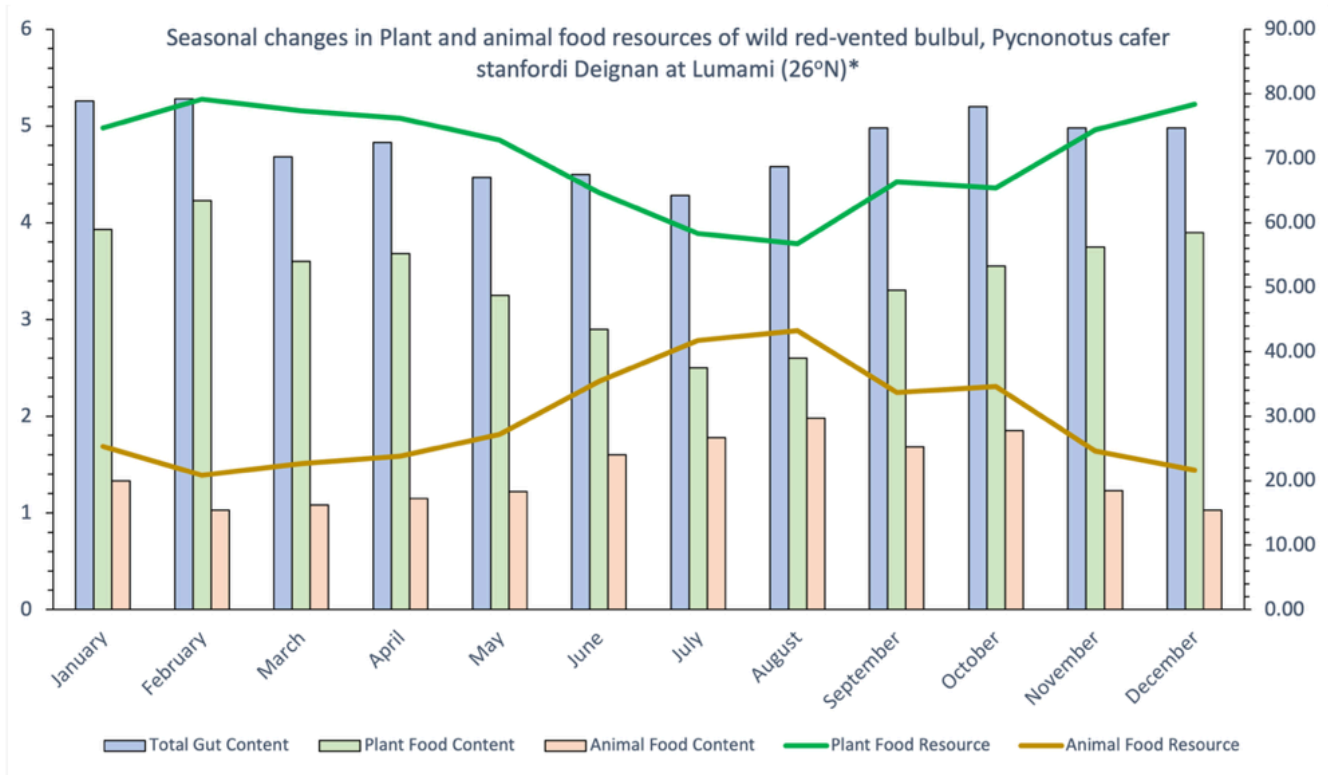


Figure 1

Chart showing the seasonal changes in Plant and animal food resources of wild red-vented bulbul and consumption, *Pycnonotus cafer stanfordi* Deignan at Lumami (26°N)*.

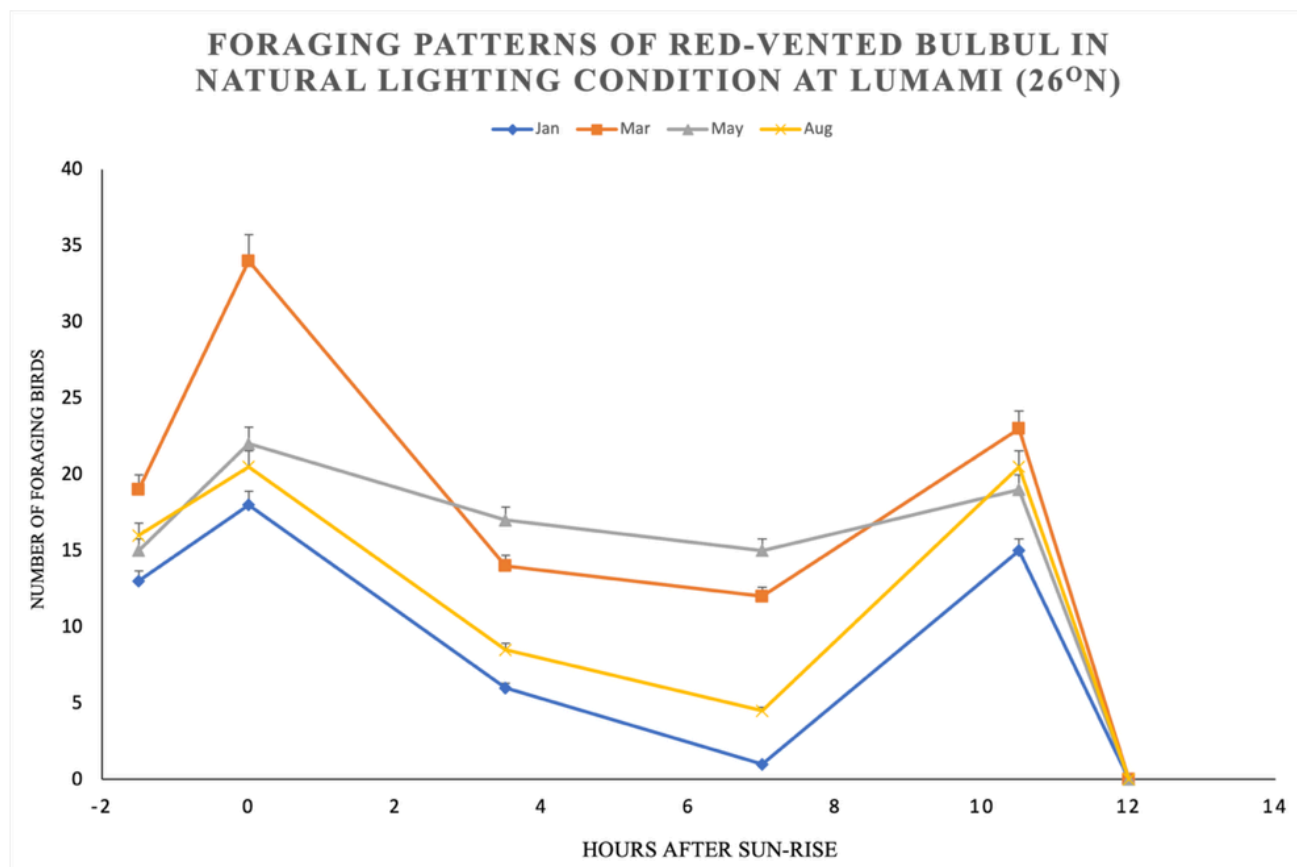


Figure 2

Data plot showing Foraging Patterns of Red-vented bulbul in natural lighting condition at Lumami (26⁰N)

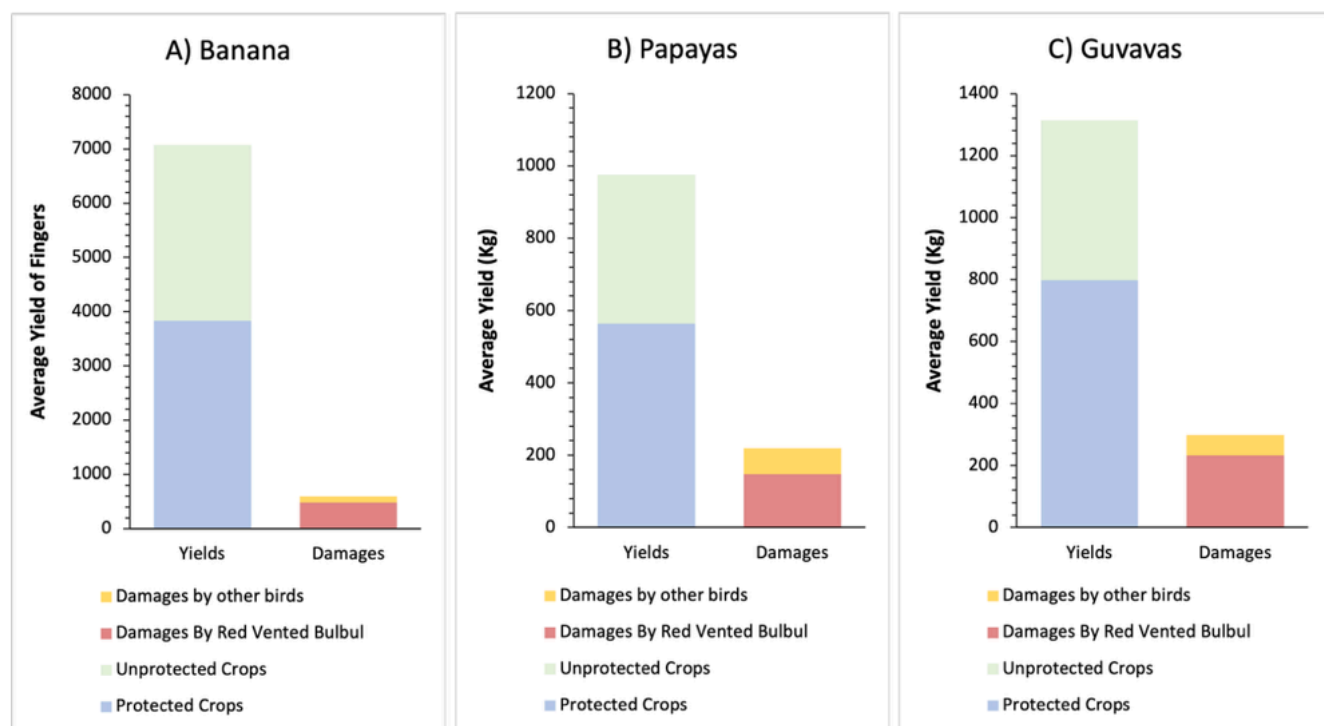


Figure 3

Bar graph showing damages to Banana (A), Papayas (B) and Guava (C) yields. n=20 in each group. *shows significance against gross yield at $p < 0.05$ level (ANOVA)



Fig 4A: Banana crop damages



Fig 4B: Guava crop damages



Fig 4C: Papaya crop damages

Figure 4

See image above for figure legend.



Figure 5

Nectarivory

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Plate1.docx](#)