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Abundance of Insect Pollinators on *Calotropis procera* in Buxar district of Bihar

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***Abstract*:** This comprehensive study sheds light on the diverse insect forager species associated with *Calotropis procera*, revealing 21 (twenty-one) species, including two unidentified ones, distributed across five orders. The population abundance assessment over a six-month period uncovered dynamic trends, with March recording the highest mean population of pollinators. Ants emerged as consistent visitors, with *Apis dorsata* dominating in December. Diversity indices analysis indicated rich pollinator diversity in areas, with the Simpson's index reflecting values from 0.942 to 0.955, suggesting a robust and diverse pollinator community. The highest species richness was in March at location having latitude- 84^{0}9'25", longitude- 25^{0}31'4". The study advocates for the conservation of pollinators with weeds as a potential strategy to address threats to biodiversity, aligning with previous research emphasizing the positive role of weeds in enhancing floral diversity and supporting insect populations.

***Keywords*:** *Calotropis procera*, Pollinators, Relative abundance, Diversity index and Bihar

Calotropis includes *Calotropis procera* and *C. gigantea* are perennial wild herb widely distributed in tropical and subtropical areas such as India, Africa, Egypt, Pakistan, Iran, Arabic islands and Australia. Calotropis is a staple in arid and marginal areas and is essential to the health of the ecosystem. Its robust root systems contribute to soil conservation, preventing erosion and aiding in the adaptation to challenging environmental conditions, thereby combating desertification (Nascimento et al., 2015). This makes calotropis instrumental in preserving the integrity of ecosystems in regions facing arid challenges. The plant's importance extends to traditional medicine and crafts, enriching the lives of local communities. Various parts of calotropis, such as roots, leaves, and latex, have been used in traditional medicinal practices for their anti-inflammatory, anti-cancer, and anti-microbial properties (Wani et al., 2017). Additionally, the fibres derived from calotropis stems are employed in crafting ropes and traditional products, contributing to local economies (Verma et al., 2018).

The calotropis flower acts as a nectar source for flower visitors and having some demonstrated co-evolutionary relationships with each other (Salau and Nasiru 2015). The flower visitors pertain to the *C. Prospera* plant, mainly from the Hymenoptera order, encompassing carpenter bees, honeybees, ants, and wasps. Additionally, there are a few species from the Diptera and Lepidoptera orders (Zafar et al., 2018). While a handful of records exist for *C. gigantea* (Jayasinghe et al., 2013, Perera and Wickramasinghe, 2014, Wijeweera et al., 2022), comprehensive studies on its associated fauna remain scarce. Consequently, the current investigation aims to assess the prevalence of insect flower visitors linked to *C. procera* plants in Dumraon district of Buxar, Bihar.

MATERIAL AND METHODS

Study area: The experiment was carried out at College Farm Veer Kunwar Singh College of Agriculture, Dumaron, Buxar under Bihar Agricultural University, Sabour, Bhagalpur during the year 2022-23 and 2023-24. Three sites with high population of *Calotropis procera* (A. Latitude- 84^{0}9'38", Longitude- 25^{0}31'40"; B. Latitude- 84^{0}9'44", Longitude- 25^{0}31'43" and C. Latitude- 84^{0}9'25", Longitude- 25^{0}31'4") were purposively sampled after conducting reconnaissance survey; these were Permanent sites of Haryana farm. The studied area was then mapped using Arc GIS.

Observations: Study on diversity and abundance of Insect pollinators on Aak were taken up at three different places of College Farm (Haryana Farm), Veer Kunwar Singh College of Agriculture, Dumraon, Buxar from December to May in each year (Fig. 1). The obtained data were pooled for further study and analysis. The diversity of insect pollinators on *Calotropis procera* was on weekly basis. There the experimental collection sites were regularly visited and samples were collected by using a hand sweeping net from 7 am to 5 pm on every week. Collected samples were preserved in the killing bottles with ethyl acetate and brought

into the laboratory for spreading the insects and photography. Identification of the pollinators was done by matching with previously identified fauna of pollinators preserved in the Insect Museum, Department of Agricultural Entomology and also with assistance of experts. Relative abundance which determines percentage of specimens of a given species in the total number of organisms collected, were calculated based on the observations taken on the number of pollinators visiting the flowers/m^2/5 min, using following formula: Relative abundance (%) = population of a particular species visiting flower/total population of all species visiting flowers x 100 (Das and Jha, 2019). The data on relative abundance of pollinators recorded during the studied period were pooled for the analysis. The diversity index to measure the species diversity in a community like Simpson's Index of Diversity and Simpson's Reciprocal Index were worked out based on pooled data based on the methods suggested by Simpson (Simpson 1949).

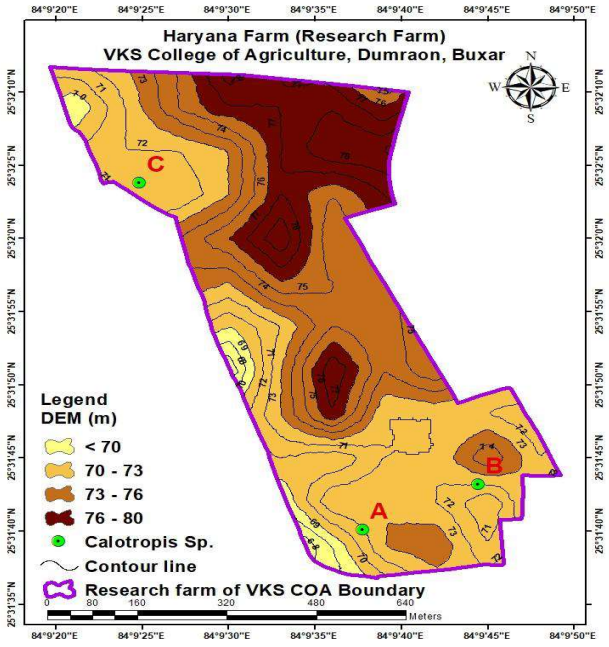

Fig. 1. Location map of studied area

RESULTS AND DISCUSSION

During the study period, a total of 21 insect forager species, including two unidentified species, were observed visiting *Calotropis procera* (Table 1). The recorded pollinators belong to five orders viz. Hymenoptera, Diptera, Coleoptera, Lepidoptera, and Orthoptera. Among these orders, the highest numbers of species (12) were observed in the Hymenoptera order, demonstrating greater activity on *C.*

Table 1. Diversity of insect pollinators on *Calotropis procera* (Aak)

Common name	Scientific name	Order	Family
Ant	*Monomorium indicum*	Hymenoptera	Formicidae
Megachilid	*Megachile lanatus*	Hymenoptera	Megachilidae
Rock honeybee	*Apis dorsata*	Hymenoptera	Apidae
Little honeybee	*Apis florea*	Hymenoptera	Apidae
Stingless bee	*Tetragonula iridipennis*	Hymenoptera	Apidae
Carpenter bee	*Xylocopa fensterata*	Hymenoptera	Xylocopidae
Carpenter bee	*X. volvoceae*	Hymenoptera	Xylocopidae
Syrphid fly	*Episyrphus sp.*	Diptera	Syrphidae
House fly	*Musca sp.*	Diptera	Muscidae
Blister beetle	*Mylabris pustulata*	Coleoptera	Meloidae
Italian honeybee	*Apis mellifera*	Hymenoptera	Apidae
Indian honeybee	*Apis cerana indica*	Hymenoptera	Apidae
Pumpkin beetle	*Aulacophora foveicollis*	Coleoptera	Chrysomelidae
Pea blue butterfly	-	Lepidoptera	Lycaenidae
Sweat bees	-	Hymenoptera	Halictidae
Ladybird beetle	*Coccinella transversalis*	Coleoptera	Coccinellidae
Short-horned grasshoppers	-	Orthoptera	Acrididae
Sweat bees	-	Hymenoptera	Halictidae
Plain Tiger Butterfly	*Dannus chrysippus*	Lepidoptera	Nymphalidae
Unidentified 1	-	Hymenoptera	-
Unidentified 2	-	Diptera	-

Table 2. Abundance of pollinators *Calotropis procera*

Pollinators			Population abundance of pollinators on *Calotropis procera*											
Common name	Scientific name	Family	December		January		February		March		April		May	
			No./Mt^2 /5 min.	Mean (%)	No./Mt^2 /5 min	Mean (%)	No./Mt^2 /5 min	Mean (%)	No./Mt^2 /5 min	Mean (%)	No./Mt^2 /5 min	Mean (%)	No./Mt^2 /5 min	Mean (%)
Ants	*Monomorium indicum*	Formicidae	2	7.61	1.75	8.64	3.42	18.41	5.25	10.92	5.58	8.06	4.8	7.87
Megachilids	*Megachile lanatus*	Megachilidae	0.67	2.55	0.25	1.23	0.58	3.12	0.5	1.04	2.08	3.00	2.93	4.80
Rock honeybee	*Apis dorsata*	Apidae	1.87	7.12	2.5	12.35	1.08	5.81	4.67	9.71	2.83	4.09	1.53	2.51
Little honeybee	*Apis florea*	Apidae	1.47	5.60	1.42	7.01	0.08	0.43	4.08	8.48	3.75	5.41	2.13	3.49
Stingless bee	*Tetragonula iridipennis*	Apidae	1.27	4.83	1.08	5.33	0.67	3.61	1.75	3.64	4	5.78	2.75	4.51
Carpenter bee	*Xylocopa fensterata*	Xylocopidae	1.13	4.30	1.08	5.33	0.92	4.95	2.67	5.55	1.03	1.49	1.03	1.69
Carpenter bee	*X. volvoceae*	Xylocopidae	1.53	5.82	1	4.94	1	5.38	3.92	8.15	2.83	4.09	3.13	5.13
Syrphid fly	*Episyrphus sp.*	Syrphidae	1.73	6.59	0.33	1.63	0.92	4.95	1.83	3.81	3.08	4.45	2.13	3.49
House fly	*Musca sp.*	Muscidae	1.33	5.06	0.58	2.86	0.58	3.12	1.92	3.99	2.75	3.97	4.6	7.54
Blister beetle	*Mylabris pustulata*	Meloidae	0.67	2.55	1.83	9.04	0.58	3.12	1.5	3.12	3	4.33	3.87	6.34
Italian honeybee	*Apis mellifera*	Apidae	0.73	2.78	1.5	7.41	0.67	3.61	1.92	3.99	4.5	6.50	2.75	4.51
Indian honeybee	*Apis ceranaindica*	Apidae	1.73	6.59	0.67	3.31	0.83	4.47	3	6.24	3.58	5.17	4.27	7.00
Pumpkin beetle	*Aulacophora foveicollis*	Chrysomelidae	0.73	2.78	1.08	5.33	1.08	5.81	2.67	5.55	5.42	7.83	3.8	6.23
Pea blue butterfly	-	Lycaenidae	0.6	2.28	1.58	7.80	0.92	4.95	1.58	3.29	4.25	6.14	3.13	5.13
Sweat bees	-	Halictidae	1.8	6.85	0.75	3.70	0.92	4.95	2.08	4.33	3.67	5.30	4.67	7.66
Ladybird beetle	*Coccinella transversalis*	Coccinellidae	1.2	4.57	1.25	6.17	0.5	2.69	0.5	1.04	3.08	4.45	2.07	3.39
Short-horned grasshoppers	-	Acrididae	1.4	5.33	0.17	0.84	0.42	2.26	1.67	3.47	3.83	5.53	3.53	5.79
Sweat bees	-	Halictidae	1.2	4.57	0.5	2.47	0.75	4.04	2.33	4.85	3	4.33	2.4	3.93
Plain Tiger Butterfly	*Dannus chrysippus*	Nymphalidae	0.75	2.85	0.75	3.70	0.83	4.47	0.75	1.56	0.75	1.08	0.75	1.23
Unidentified 1	-	-	0.93	3.54	0.17	0.84	0.58	3.12	2.25	4.68	3.25	4.69	2.07	3.39
Unidentified 2	-	-	1.53	5.82	1.17	5.78	1.25	6.73	1.25	2.60	3	4.33	3.2	5.25
Total			26.27		21.41		18.58		48.09		69.26		61.54	

Note: Mean pooled population abundance of pollinators on *Calotropis procera* during 2022-23 and 2023-24

Table 3. Diversity index of insect pollinators on *Calotropis* spp

Months	Location A			Location B			Location C		
	Latitude: 25°31'40", Longitude: 84°09'38"			Latitude: 25°31'43", Longitude: 84°09'44"			Latitude: 25°31'40", Longitude: 84°09'25"		
	(D)	(1-D)	(1/D)	(D)	(1-D)	(1/D)	(D)	(1-D)	(1/D)
December	0.051	0.949	19.677	0.049	0.951	20.263	0.052	0.948	19.408
January	0.051	0.949	19.679	0.052	0.948	19.239	0.049	0.951	20.533
February	0.051	0.949	19.468	0.048	0.952	21.000	0.054	0.946	18.600
March	0.052	0.948	19.404	0.049	0.951	20.545	0.054	0.946	18.533
April	0.058	0.942	17.251	0.053	0.947	19.024	0.045	0.955	22.165
May	0.048	0.952	20.744	0.043	0.957	23.290	0.047	0.953	21.223

Simpson's Index (D), Simpson's Diversity Index (1-D), Simpson's Reciprocal Index (1/D)

procera compared to other insect groups. In contrast, only one species from the Orthoptera order was identified foraging on the plants. Conversely, three species from both Diptera and Coleoptera orders, followed by two species from Lepidoptera, were observed visiting the plant (Fig. 1). When the family wise relative abundance of insect pollinators was taken into consideration it is observed that maximum no. of species visiting *C. Procera* belongs to the family Apidae followed by two species of both Xylocopidae and Halictidae. (Wijeweera et al., 2022) documented *Xylocopa* spp. (Carpenter bee), *A. cerana* Fabricius (Honeybee), and *D. chrysippus* (Plain Tiger) were commonly recorded as pollinators of *C. Gigantean*. Charan et al. (2020) reported that *C. procera* attracted 27 insect pollinators from three orders and 14 tribes in the Thar Desert of Rajasthan. Minor variations in the findings could be attributed to differences in geographical locations and climatic conditions. Baghele and Masram (2023) observed 18 insect species on the plant during the summer season. Among these, five belonged to Order Hemiptera, four to Diptera, three to Coleoptera, two to Lepidoptera, two to Hymenoptera, and two to Araneae, with the potential for acting as pollinators in close proximity to the present study. Baburao (2021) documented sixty-two insect species associated with milkweed, representing nine orders, 40 families, and 54 genera. Of these, 17.74% of the species were identified as floral visitors.

Highest mean population of pollinators was observed in April (69.26/mt^2/5 minute) followed by May, December and January. The lowest. was observed in February (18.58 / mt^2/5 minute). Ants were most promising visitors on the plant during all months of study except in January. In this month *Apis dorsata* was the most frequent visitors (2.5 /mt^2 /5 min) visited the flowers for predation of soft bodied insects and unknowingly pollinates the flowers. Minimum number and percent mean of population of pollinators December to May was Pea blue butterfly. Charan et al. (2020) documented *Trigona iridipennis* to be the most abundant (18.85 / mt^2/ 5 minutes) and *Chrysosoma* spp (1.44 / mt^2/ 5 minutes) as the least abundant visitor in the summer while *Apis florea* as the most abundant (14.70 /mt^2/ 5 minutes) pollinator in the winter season. On the basis of insect foragers recorded, mean number of pollinators per mt^2 per 5 minutes, Hymenoptera has been observed as the most abundant order while Apidae as the most abundant family.

Simpson's index spans from 0 to 1, where a value of zero signifies lower species diversity, while one indicates a richness of diversity. According to the Simpson's index Calotropis areas exhibited a high richness of pollinator diversity (ranging from 0.942 to 0.955) throughout the study months (Table 3). The maximum species richness values were noted at location C in March (0.955) conserving pollinators with weeds can offer an alternative to addressing threats to biodiversity, consistent with findings by Steffan-Dewenter and Westphal (2008). Rollin et al. (2016) also revealed that despite being formidable competitors, weeds contribute to floral diversity in agricultural landscapes and provide food for insects in exchange for pollination. Chatterjee et al. (2020) predicted thresholds of 27% and 18% for natural vegetation cover to safeguard pollinator services in brinjal and mustard, respectively. Rollings and Goulson (2019) further support this perspective.

CONCLUSION

The study identified a diverse array of insect pollinators visiting *Calotropis procera*, with a total of 21 species across five orders. The Hymenoptera order exhibited the highest species richness, underscoring its significant role in the pollination of *C. procera*. Apidae was being the most prevalent. Ants emerged as the most consistent visitors, except in January when *Apis dorsata* was the most frequent. This research investigates the importance of conserving pollinator habitats, including weedy species like *C. procera*,

which play a crucial role in maintaining biodiversity and ecosystem services. The study's findings are consistent with broader ecological perspectives that highlight the contribution of weeds to floral diversity and their potential in supporting pollinator communities.

AUTHORS CONTRIBUTION

Gautam Kunal planned the design of the study, carried out the experiments and drafted the manuscript. Jitendra Kumar conceptualized the work and collected the data .Love Kumar contributed in mapping and statistical analysis of the data. Ramesh Nath Gupta reviewed and corrected the manuscript. All authors read and approved the final manuscript.

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