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Ant Diversity and Community Structure (Hymenoptera: Formicidae) in Soybean, Pigeon Pea, and Cotton Agro-ecosystems of Bhatkuli, Amravati District, Maharashtra (India)

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ABSTRACT

Ants are ecologically important components of agricultural ecosystems, contributing to soil modification, nutrient cycling, and regulation of arthropod populations. Despite their significance, crop-specific information on ant assemblages from the semi-arid agricultural landscapes of Vidarbha, Maharashtra, remains limited. The present study investigates ant diversity and community composition across three major kharif crops—soybean (*Glycine max*), pigeon pea (*Cajanus cajan*), and cotton (*Gossypium* spp.)—cultivated in Bhatkuli tehsil of Amravati district. Field sampling conducted from July to December 2024 using pitfall traps and timed hand collection resulted in 1,270 individuals representing 12 species, 11 genera, and five subfamilies. Soybean fields recorded the highest diversity (Shannon–Wiener index, H′ = 2.18) and evenness (E = 0.91), whereas cotton fields exhibited lower diversity (H′ = 1.84) and higher dominance (D = 0.21), largely due to the prevalence of *Camponotus compressus*. The results demonstrate that crop architecture and management intensity strongly influence ant community structure. The study emphasizes the importance of crop heterogeneity in conserving beneficial ant fauna and enhancing ecosystem services in the agricultural landscapes of Vidarbha.

KEYWORDS: *Ant diversity, Agro-ecosystems, Bhatkuli, Soybean, Cotton, Pigeon Pea.*

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INTRODUCTION

Ants (Hymenoptera: Formicidae) are one of the most ecologically significant insect groups in terrestrial ecosystems due to their high abundance and functional diversity. They contribute to several ecosystem processes, including soil aeration, decomposition of organic matter, seed dispersal, and predation on other invertebrates, thereby playing a crucial role in maintaining ecosystem balance (Folgarait, 1998; Hölldobler & Wilson, 1990).

Because ants respond quickly to changes in environmental conditions and habitat structure, they are widely recognized as effective bioindicators of ecosystem health and land-use intensity (Agosti et al., 2000; Andersen, 1997). Their community composition often reflects variations in vegetation type, disturbance level, and microclimatic conditions.

Agricultural landscapes in the Vidarbha region of Maharashtra are predominantly semi-arid and heavily influenced by seasonal cultivation practices. In Amravati district, soybean, pigeon pea, and cotton are the main kharif crops. These crops differ significantly in their structural complexity and management practices. Soybean fields generally maintain dense ground cover, pigeon pea provides a more vertically complex habitat, while cotton fields are frequently subjected to intensive management practices such as pesticide application and mechanical disturbance.

Although ant diversity has been documented in forest and urban ecosystems of Amravati district (Chavhan et al., 2011; Dhote, 2015), comparatively fewer studies have focused on agricultural systems. As a result, there is limited understanding of how different crop types influence ant community structure in this region. The present study aims to assess and compare ant diversity across soybean, pigeon pea, and cotton agro-ecosystems in Bhatkuli tehsil and to evaluate

how crop-specific characteristics influence community organization.

Materials and Methods

➢ Study Area

The study was conducted in agricultural fields of Bhatkuli tehsil (20°54′ N, 77°36′ E), Amravati district, Maharashtra. The region experiences a semi-arid climate with high summer temperatures and monsoonal rainfall during June–September. The soils are predominantly deep black cotton soils, suitable for kharif cultivation.

➢ Sampling Methods

Field sampling was carried out from July to December 2024 in three crop ecosystems: soybean, pigeon pea, and cotton. In each crop field, five pitfall traps (10 cm diameter) containing 70% ethanol were installed flush with the soil surface at intervals of 10 m to collect ground-foraging ants, following standard biodiversity sampling protocols (Agosti et al., 2000). Traps were operated for 48 hours. In addition, timed visual encounter surveys of 30 minutes per field were conducted during morning (08:00–10:00 h) and evening (16:00–18:00 h) hours to collect actively foraging ants.

➢ Identification and Data Analysis

Collected specimens were preserved in ethanol and identified using standard taxonomic keys following Bolton (1994) and Tiwari (1999). Species richness and abundance data were analyzed to evaluate the structure of ant communities across different crop types.

Biodiversity was quantified using the Shannon–Wiener diversity index (H′), Simpson's dominance index (D), and Pielou's evenness index (E).

➢ Shannon–Wiener index was calculated as:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where $p_i = \frac{n_1}{N'}$ is the number of individuals of the i^{th} species, N is the total number of individuals, and S is the total number of species.

➢ Simpson's dominance index was calculated using:

$$D = \sum_{i=1}^{S} p_i^2$$

➢ Pielou's evenness index was computed as:

$$E = \frac{H'}{In\ S}$$

These indices were used to compare species diversity, dominance, and evenness patterns of ant communities among the studied crop systems.

Results

A total of 1,270 ant individuals representing 12 species, 11 genera, and five subfamilies were recorded from the three agro-ecosystems studied. The subfamily Myrmicinae exhibited the highest species richness, followed by Formicinae.

Table 1. Checklist and abundance of ant species recorded from different agro-ecosystems of Bhatkuli, Amravati

Subfamily	Scientific Name	Soybean	Tur	Cotton	Total
Myrmicinae	*Monomorium pharaonis*	120	45	30	195
	Pheidole sharpi	95	40	25	160
	Crematogaster hespera	30	110	15	155
	Solenopsis geminata	50	20	85	155
	Meranoplus bicolor	40	10	5	55
Formicinae	*Camponotus compressus*	45	60	140	245
	Camponotus sericeus	20	35	50	105
	Oecophylla smaragdina	5	55	10	70
	Paratrechina longicornis	35	15	20	70
Dolichoderinae	*Tapinoma melanocephalum*	15	5	10	30
Pseudomyrmecinae	*Tetraponera rufonigra*	0	15	0	15
Ponerinae	*Leptogenys processionalis*	10	5	0	15
Total Individuals		**465**	**415**	**390**	**1,270**

Soybean fields recorded the highest Shannon–Wiener diversity (H′ = 2.18) and evenness (E = 0.91). Cotton fields exhibited the highest dominance (D = 0.21), reflecting the numerical dominance of *Camponotus compressus*.

Table 2. Diversity indices of ant communities across different crops

Index	Soybean	Tur (Pigeon Pea)	Cotton
Species Richness (S)	11	11	9
Shannon-Wiener (H')	**2.18**	2.05	1.84
Simpson's Index (D)	0.14	0.16	**0.21**
Evenness (E)	0.91	0.85	0.82

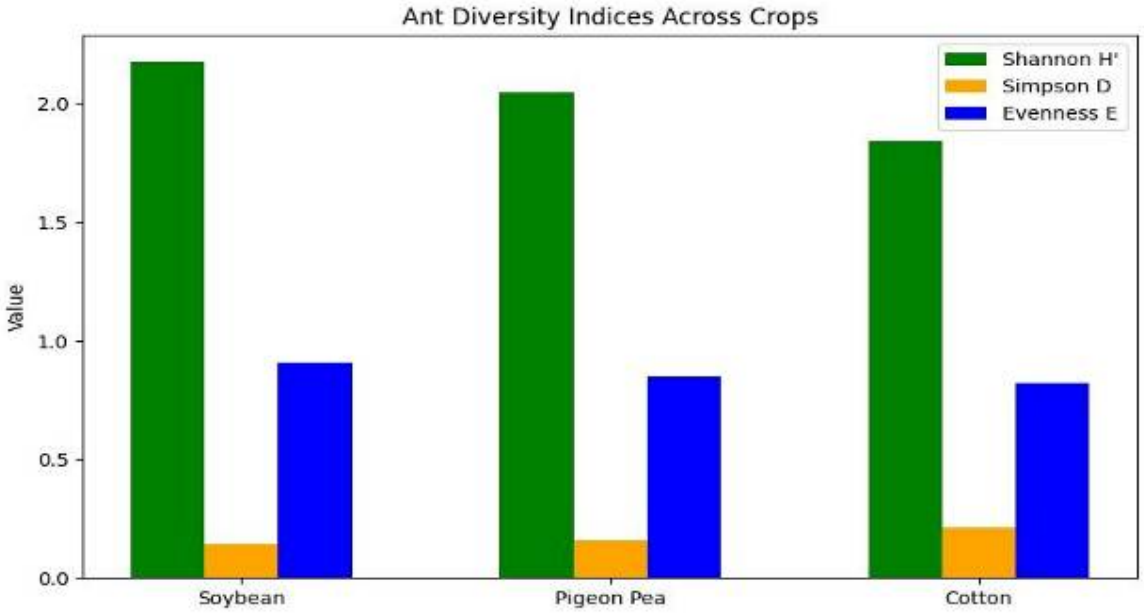

Fig 1A: **Ant Diversity Indices Across Different Crop Ecosystems**

Comparison of Shannon–Wiener index (H′), Simpson's dominance index (D), and Pielou's evenness index € across soybean, pigeon pea, and cotton agro-ecosystems of Bhatkuli, Amravati district.

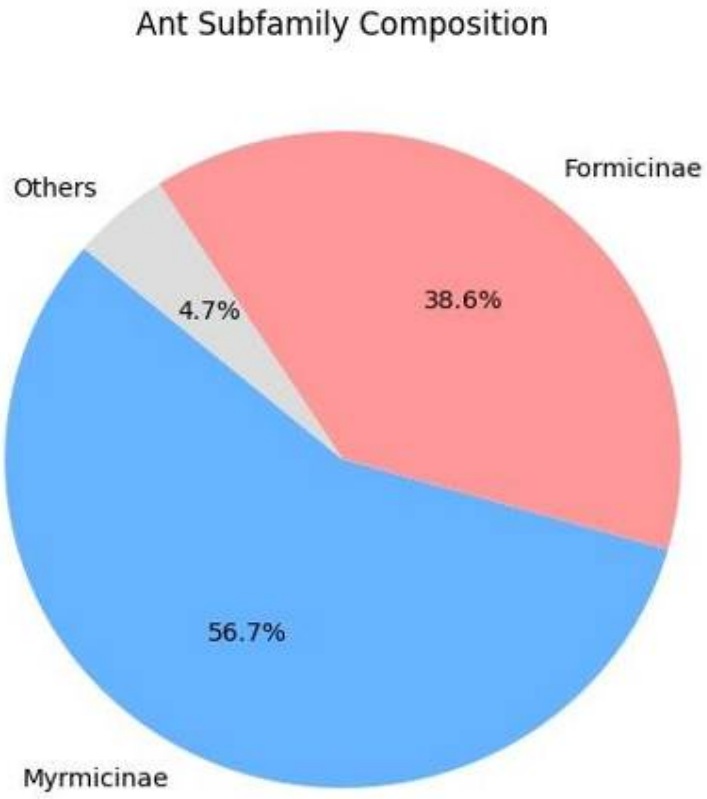

Fig 1B: Relative Abundance of Ant Subfamilies in Agro-ecosystems

Proportional distribution of ant subfamilies recorded from soybean, pigeon pea, and cotton fields showing dominance of Myrmicinae and Formicinae groups.

Discussion

The present study demonstrates that ant community structure in Bhatkuli agro-ecosystems is strongly influenced by crop type and associated habitat characteristics. The higher ant diversity observed in soybean fields is likely due to the dense vegetation, which moderates soil temperature and moisture, creating favorable conditions for a wide range of species, particularly Myrmicinae (Chate & Chavan, 2021). This pattern aligns with findings from Nanded, where Syeda Gulrez & Chavan (2022) reported that low-disturbance, dense soybean canopies support diverse ant assemblages.

Cotton fields exhibited lower diversity and higher dominance, largely due to the prevalence of *Camponotus compressus*, a species well-adapted to open canopies and frequent anthropogenic disturbance. Similar dominance patterns have been reported in cotton-growing regions of Vidarbha, where disturbance-tolerant, thermophilic species prevail (Kadu et al., 2016).

Pigeon pea fields showed intermediate diversity, reflecting their mixed structural characteristics, which provide both ground-level and arboreal niches for various ant species.

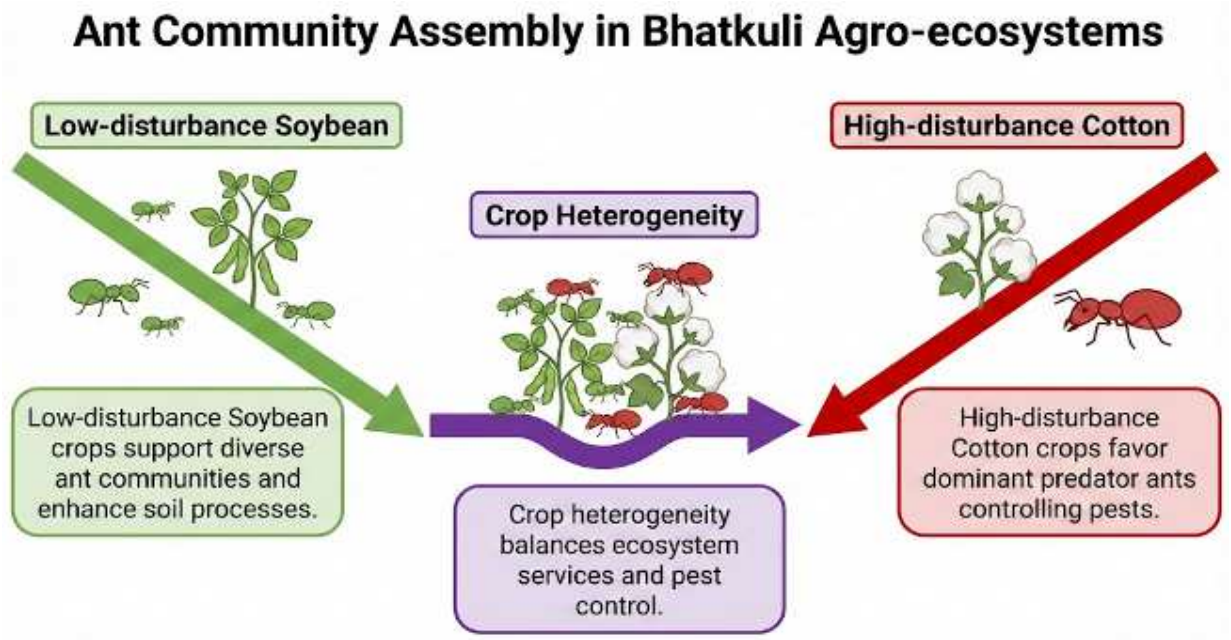

Figure 1C: Conceptual flow chart illustrating factors influencing ant community structure in Bhatkuli agro-ecosystems

- Green Pathway: Low-disturbance crops like soybean support diverse ant communities, enhancing soil processes.
- Red Pathway: High-disturbance crops like cotton favor dominant predators controlling pests.
- Purple Pathway: Crop heterogeneity balances ecosystem services and pest control.
- Crop type and associated management practices act as environmental filters shaping ant assemblages. Low-disturbance crops such as soybean support higher diversity, whereas high-disturbance crops like cotton favor dominance by a few generalist species.

Conclusion

The present study provides a crop-wise assessment of ant diversity in the agricultural landscapes of Bhatkuli tehsil, Amravati district. A total of 12 ant species belonging to 11 genera and five subfamilies were recorded across soybean, pigeon pea, and cotton agro-ecosystems. Crop identity emerged as a key factor influencing species richness, dominance, and evenness. Legume-based crops supported more balanced ant communities, whereas cotton fields were characterized by dominance of a few generalist species. Promoting crop heterogeneity and minimizing disturbance may help conserve beneficial ant fauna and enhance ecosystem services in the agricultural landscapes of Vidarbha.

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