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DIVERSITY OF SPIDERS IN CORN FIELD (*Zea mays*) IN BOGOR, WEST JAVA

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Diversiti
Laba-laba
Lahan jagung

ABSTRAK

Arthropoda memiliki peran penting dalam fungsi ekologi. Laba-laba merupakan salah satu arthropoda yang umumnya menjadi predator di agroekosistem. Sebagaimana beberapa penelitian terdahulu, laba-laba diketahui sebagai penekan hama di lahan pertanian. Penelitian ini bertujuan untuk mengetahui keanekaragaman dan karakteristik laba-laba di lahan jagung. Di setiap lokasi, laba-laba dikumpulkan dengan menggunakan metode semi kuantitatif dan perangkap jebakan. Sebanyak 438 spesimen dewasa dikumpulkan dari 40 plot. Analisis survei arthropoda laba-laba yang ditemukan di lahan jagung di Bogor menunjukkan adanya 67 spesies dari 53 genus dan 17 famili. Jumlah spesies yang ditemukan lebih banyak pada fase generatif tanaman jagung dibandingkan dengan fase vegetatif. Keanekaragaman laba-laba dipengaruhi oleh umur tanaman dan vegetasi non-tanaman. Oxyopidae, Lycosidae, dan Linyphiidae merupakan famili laba-laba dengan kelimpahan tertinggi, selain itu Lycosidae dan Linyphidae adalah famili laba-laba yang memiliki kekayaan jenis laba-laba tertinggi di lahan jagung.

Keywords:
Corn field
Diversity
Spider

ABSTRACT

Arthropods play an important role in ecological functions. Spiders are arthropods that generally act as predators in agroecosystems. Several studies suggest that spiders are effective in pest suppression in crop fields. The objectives of this research are to investigate the diversity and guild characteristics of spiders in corn fields. In each location, spiders were collected using semi-quantitative methods and pitfall traps. A total of 438 adult specimens were gathered from 40 plots. An analysis of arthropod surveys of spiders found in eight corn fields in Bogor indicates the presence of 67 species across 53 genera and 17 families. The number of species found was higher during the generative phase of the corn plants compared to the vegetative phase. Spider diversity was influenced by cropping age and non-crop vegetation. Oxyopidae, Lycosidae, and Linyphiidae are families with the highest abundance, while Lycosidae and Linyphiidae exhibit the greatest species richness of spiders in corn fields.

INTRODUCTION

Arthropods are organisms that play a role in ecological functions. In agroecosystems, arthropods exhibit high diversity and abundance. Pereira et al. (2010) studied arthropods in bean crops with a canopy, observing results from sampling in the second year that included as many as 34 species of arthropods (detritivores (3), parasitoids (7), herbivores (10), and predators (14)). Research by Settle et al. (1996) examined as many as 765 species, including spiders and insects (17% herbivores, 24% parasitoids, 19% detritivores and plankton eaters, and 40% predators) in irrigated rice fields.

Corn is a plant from the Graminae family, subfamily Myadeae, that has distinct physical structures and characteristics at each stage of its growth. Corn farming is also inseparable from human management practices such as tillage, fertilization, and weeding. Corn is an important commodity as food, making it widely cultivated, especially among the people of Indonesia. With this background, increasing maize production through pest management using natural enemies like spiders is anticipated to be sustainable.

Cornfields create an important artificial ecosystem for arthropod diversity. Sweet corn plantations in Tanjung Slamet, Medan recorded 1,747 arthropod individuals belonging to 9 orders, 23 families, and 31 species; besides spiders, (Araneidae) are arthropods with a high frequency (Tambunan, Bakti, & Zahara 2013). Another arthropod study by Suliansyah et al. (2022) in maize plantations in West Pasaman, West Sumatra showed that arachnids, dominated by spiders, represented 3% of the entire arthropod diversity. According to Marc, Canard & Ysnel (1999), spiders comprise a significant portion of the total diversity in agroecosystems. On cultivated land, spiders are known to be abundant macroarthropods with a high frequency of occurrence. However, previous research addressing arthropods in agroecosystems has primarily focused on alpha diversity, with few linking it to the characteristics of cultivated crops.

Regions in West Java, particularly Bogor Regency, are known for their extensive corn crops. While research on arthropod diversity in corn plantations has been conducted, studies on spider composition have never been performed. This study aims to determine the diversity and guild characteristics of spiders in corn plantations.

METHODS

Research Location

The research was conducted from January to July 2016. Sampling of corn plantations took place in Cijeruk Subdistrict and Bojong Kidul Village, Bojong Gede Subdistrict. Eight locations were examined, categorized by three age groups of corn plants, including S.F1 and S.F2, which are corn plantations on sloping land with an intercropping system involving chili, aged 78 days and with no pesticide application. S.C1 and S.C2 are locations near settlements with a monoculture system, aged 50 days/pollination period. S.A1 is located near the settlement with an intercropping system involving bengkuang, aged 75 days/harvest. S.A2 is another location near settlements with a monoculture system, aged 47 days/pollination period. Finally, S.M1 and S.M2 are locations near settlements with a monoculture system, aged 20-25 days/vegetative period.

Table 1. Descriptive table of corn plantings in the 8 location

Location	code	addition
1	S.F1	Plot on sloping soil intercropped with chili, 78 days old and without
2	S.F2	pesticide application.
3	S.C1	Plot near residential area with monoculture system, 50 days
4	S.C2	old/pollination period.
5	S.A1	Plot near residential area with an intercropping system with *Pachyrhizus erosus* combine plantation, age 75 days/ harvest
6	S.A2	Plot near residential area with monoculture system, 47 days old/pollination period
7	S.M1	Plot near residential area with monoculture system, age 20-25
8	S.M2	days/vegetative period

The plants bordering the S.F1 and S.F2 corn plantations included *Musa sp*. (banana), *Carica sp*. (papaya), and *Cordyline fruticosa* (hanjuang). Additionally, wild plants such as taro, *Imperata cylindrica* (alang-alang), *Ageratum conyzoides* (babandotan), *Crassocephalum crepidioides* (sintrong), *Limnocharis flava* (genjer), *Eleusine indica* (jampang grass), *Bidens sp*., *Centella asiatica* (antanan), *Cyperus sp*., Lamiaceae, ferns, *Justicia sp*., *Cynodon dactylon*, *Rorippa indica*, *Panicum sp*., *Paspalum sp*., and *Digitaria sp*. are also present. The composition of plants living around or in the crops often serves as a habitat for spiders and surrogate hosts for pests.

Data Collection

The research was conducted on 10 m x 10 m plots containing approximately 70 corn plants. Eight locations were sampled, each with five randomly placed plots. Sampling took place in these eight locations from February to May. Spider samples were collected using semi-quantitative methods and pitfall traps. The semi-quantitative method, according to Cardoso et al. (2008) with modifications, consists of four sampling techniques:

1. Aerial hand collection, which involves searching on leaves, branches, twigs, tree trunks, and spaces between stands. This sampling is conducted from above the knee (50 cm from the ground) to the maximum reachable height (2 m).
2. Ground hand collection, which involves searching among litter, wood, rocks, and plants from the knee to the ground surface.
3. Sweeping, where spider collection is done by swinging a net across each observation plot for a total of 100 swings. The diameter of the net used was 30 cm, with a range of 1 m to the left and right. Sampling in each transect was repeated in different plots.

4. Pitfall traps were installed at five points on each 10x10 m plot. Plastic containers filled with a solution containing 2% formalin (Selden, 1998) and detergent were placed at each corner and at the diagonal meeting points of the observation plot. Finnamore et al. (2002) stated that the number of traps is adjusted according to the area of observation. The traps were left in place for 3 x 24 hours, with a diameter of 7 cm and a height of 9 cm.

Data Analysis

Data were tabulated in Excel format to serve as a database. Estimate S software version 9.1 was used to calculate the Jackknife 1 mean value for determining species accumulation curves (Heltshe & Forrester, 1983; Colwell, 2013), and Palynological Statistic software (PAST) utilized Non-Metric Dimensional Scaling (NMDS) analysis to describe changes in species composition with corn plant age.

RESULT AND DISCUSSION

Species Diversity and Richness

A total of 438 spiders from 67 species across 17 families were recorded in cornfields. The ratio of collected spider species to the estimated number (Jacknife 1) was 69% (Figure 1). This indicates that at least 31% more species were expected to be collected than were actually gathered.

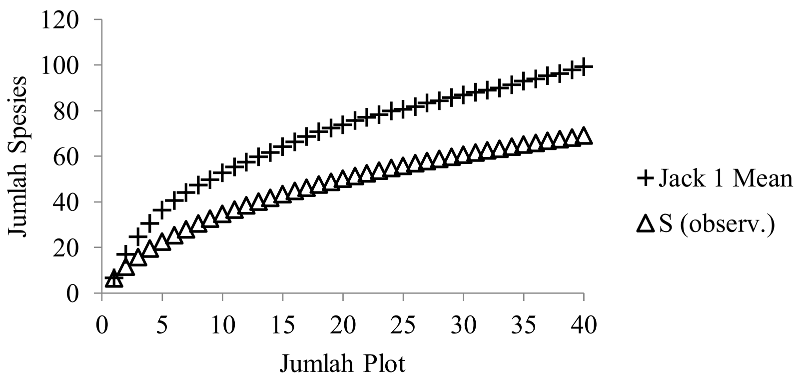

Figure 1. Species accumulation curves at eight locations in Corn Fields

Spider diversity in corn crops is related to plant age and the presence of wild plants. The study site exhibited low variation in the number of species due to its simple plant structure and diversity. Based on observations, corn plants during flowering and fruiting periods had a higher number of spider individuals and species compared to vegetative corn plants. This may be due to the high intensity of human intervention on young plants. Uprooting non-crop plants and spraying pesticides are activities that can inhibit the colonization of natural enemies, especially spiders, in agricultural systems. Spiders are arthropods sensitive to their environment. Additionally, an experimental investigation conducted in a small wheat field showed a difference in the density and richness of spiders, with high density recorded in zero-tillage sown fields and the lowest in low-input fields (Butt & Sherawat, 2012). Holland (2003) states that spiders are the most sensitive macro-arthropods to management practices in the fields. This intense human intervention during the vegetative phase of corn planting leads to fewer spiders present. Table 2 shows the diversity of spiders in corn crops. Location S.C1 had the highest number of individuals and species. This location is a generative phase corn plantation (flowering) with a height of more than 150 cm. Corn plants with these characteristics are those with dense leaf cover and non-crop plants densely growing on the ground surface.

Table 2. Table of richness and abundance of spiders in corn plantations by day of planting.

Location	S.M1	S.M2	S.C2	S.C1	S.A2	S.A1	S.F1	S.F2
Sp. richness	9	15	19	29	22	13	13	23
Density	22	30	68	119	54	42	64	41

Species Composition of Corn Field Spiders

Table 3 illustrates the families and species of spiders in cornfields based on their hunting characteristics. *Oxyopes sp*. from the family Oxyopidae emerges as the dominant spider in cornfields with an 'ambush hunter' trait. Lycosidae and Linyphiidae are the predominant spider families found on the ground. Lycosidae actively hunts ground prey as ground hunters, while Linyphiidae is as ambush hunters (Cardoso et al., 2011).

Table 3. Hunting characters (guilds) of spiders in corn plantations

Family	Species	Hunting Type	Abundance	
			PT	SK
Araneidae	*Neoscona nautica*	Orb web	-	1
Araneidae	*Cyrtarachne sp.*	Orb web	-	1
Araneidae	*Araneus sp.*	Orb web	-	2
Clubionidae	*Clubio terrestris*	Other hunter	3	-
Clubionidae	*Cheiracanthium sp.*	Other hunter	4	-
Corinnidae	*Apochinomma sp.*	Ground hunter	2	-
Corinnidae	*Koppe sp.*	Ground hunter	3	-
Corinnidae	*Corinnomma thorelli*	Ground hunter	2	-
Desidae	*Badumna sp.*	Ground hunter	9	-
Gnaposidae	*Synaphosus sp.*	Ground hunter	1	-
Linyphiidae	*Erigone bifurca*	Other hunter	10	-

Linyphiidae	*Erigone sp.1*	Other hunter	6	-
Linyphiidae	*Erigone sp.2*	Other hunter	3	-
Linyphiidae	*Atypena formosana*	Other hunter	1	-
Linyphiidae	*Tmeticus sp.*	Other hunter	4	-
Linyphiidae	*Neriene sp.*	Other hunter	13	-
Linyphiidae	*Phyllarachne sp.*	Other hunter	14	-
Linyphiidae	*Plectembolus sp.*	Other hunter	2	-
Linyphiidae	*Mitrager sp.*	Other hunter	4	-
Linyphiidae	*Prosoponoides sp.*	Other hunter	4	-
Liocranidae	*Sesieutes sp.*	Ground hunter	4	-
Liocranidae	*Oedignatha sp.*	Ground hunter	1	-
Lycosidae	*pardosa nigriceps*	Ground hunter	3	-
Lycosidae	*Trochosa semoni*	Ground hunter	6	-
Lycosidae	*Venonia coruscans*	Ground hunter	3	-
Lycosidae	*Passiena spinicrus*	Ground hunter	1	-
Lycosidae	*Pardosa birmanica*	Ground hunter	6	-
Lycosidae	*Pardosa pusiola*	Ground hunter	1	-
Lycosidae	*Pardosa astrigera*	Ground hunter	41	-
Lycosidae	*Pardosa sumatrana*	Ground hunter	21	-
Lycosidae	*Allocosa sp.*	Ground hunter	14	-
Lycosidae	*Pardosa sumatrana*	Ground hunter	15	-
Lycosidae	*Draposa tenasserimensis*	Ground hunter	57	-
Lycosidae	*Hippasa sp.1*	Ground hunter	1	-
Lycosidae	*Hippasa sp.2*	Ground hunter	1	-
Lycosidae	*Pardosa sp.*	Ground hunter	5	-
Lycosidae	*Pardosa pseudoannulata*	Ground hunter	16	-
Ochyroceratidae	*Althepus javanensis*	Sheet web	-	1
Oonopidae	*Orchestina sp.*	Ground hunter	4	-
Oonopidae	*Ischnothyreus sp.*	Ground hunter	10	-
Oonopidae	*Plectoptillus sp.*	Ground hunter	5	-
Oxyopidae	*Oxyopes javanus*	Ambush hunter	-	76
Oxyopidae	*Oxyopes lineatipes*	Ambush hunter	-	21
Oxyopidae	*Oxyopes macilentus*	Ambush hunter	-	4
Salticidae	*Bianor incitatus*	Other hunter	-	3
Salticidae	*Sitticus sp.*	Other hunter	-	1
Salticidae	*Cocalodes sp.*	Other hunter	1	-

Salticidae	*Phlegra sp.*	Other hunter	1	-
Salticidae	*Evarcha selenaria*	Other hunter	-	1
Tetragnathidae	*Tetragnatha extensa*	Orb web	-	1
Tetragnathidae	*Tetragnatha sp.1*	Orb web	-	1
Tetragnathidae	*Tetragnatha sp.2*	Orb web	-	4
Tetraghnatidae	*Leucauge celebesiana*	Orb web	-	1
Tetragnathidae	*Tetragnatha javana*	Orb web	-	2
Tetragnathidae	*Tylorida striata*	Orb web	-	1
Theraposidae	*Phlogiellus atriceps*	Sensing web	1	-
Theridiidae	*Steatoda sp.*	Space web	1	-
Theridiidae	*Dipoena sp.*	Space web	-	2
Theridiidae	*Theridion sp.*	Space web	1	-
Theridiidae	*Chrysso sp.*	Space web	-	2
Theridiidae	*Steatoda cingulata*	Space web	2	-
Theridiidae	*Coscinida sp.*	Space web	1	-
Thomisidae	*Misumena sp.*	Ambush hunter	-	3
Thomisidae	*Diaea zonura*	Ambush hunter	-	1
Thomisidae	*Thomisus callidus*	Ambush hunter	-	1
Thomisidae	*Runincia sp.*	Ambush hunter	-	1
Zodariidae	*Mallinella sp.*	Ground hunter	1	-

Description: PT is Pitfall Trap method and SK is semi-quantitative method.

Figure 2 shows the NMDS dimensions across the eight sites. Coordinate 1 illustrates the gradient of change in spider species composition that correlates with crop age. Arthropods in corn crops, especially pests, include flightless insects such as hoppers, caterpillars, and grasshoppers, making hunter-type spiders more adaptive. Based on field observations, *O. javanus* is a species resistant to open ecosystems and is found in corn plants that are 10-15 days old. The lynx spider *Oxyopes salticus* Hentz preferentially feeds on prey organisms in the 1- to 2.9-mm size class (Maloney, Drummond, & Alford. 2003). Species commonly found in corn plantations that have a high abundance include *Oxyopes javanus*, *Draposa tenasserimensis*, *Pardosa sumatrana*, *Pardosa astrigera*, and *Ischnothyreus sp*. The ecosystem structure in corn plantations leads to a lack of microhabitats suitable for the construction of web-making spiders and results in exposure to wind and rain due to the absence of cover. Compared to weaver spiders, hunter spiders can endure high levels of disturbance, which may explain their greater abundance (Tsai et al., 2006). Based on field samples, Oxyophidae, Lycosidae, and Linyphiidae are three families that can serve as bioindicators in corn fields. This is supported by research from Marc, Canard, & Ysnel (1999), which presents the value of spider bioindicators by examining population and community levels.

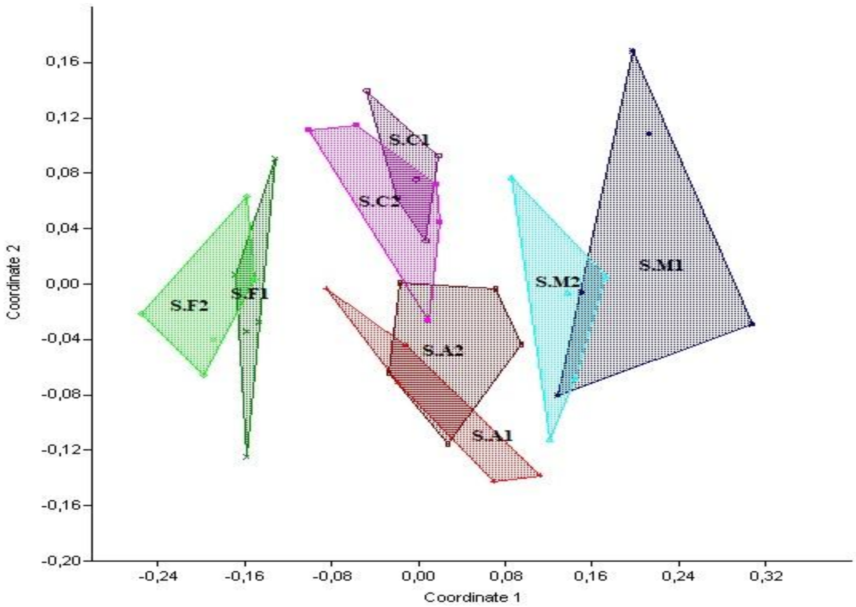

Figure 2. NMDS dimensions in the eight corn cropping locations

The vegetative phase of corn planting at 20-25 hst (S.M1 and S.M2) exhibited low spider richness and abundance. In the generative phase (S.C2, S.C1, and S.A2), spider richness and abundance increased, then decreased again at harvest (S.A1, S.F1, and S.F2). Corn plantations during the flowering period showed high individual abundance and species richness of spiders compared to cob corn plantations. During flowering, corn plant pests increase and become more varied, facilitating a rise in corn predators, particularly spiders. This aligns with Suana's (2005) statement that in rice fields, the diversity and species richness of spiders increase in tandem with plant age development. The growing diversity and abundance of pests in the flowering phase also heighten the potential for spiders to emerge, utilizing various hunting strategies that differ in their efficiency for capturing specific prey types. Consequently, spiders employing different hunting techniques may target similar prey kinds in varying amounts, potentially impacting their effectiveness in controlling herbivores (Michalko, Pekár, & Entling, 2019).

Rypstra & Carter (1999) noted that agricultural practices characterized by high structural complexity (such as intercropping, mulching, and varied tillage practices) enhance the abundance and diversity of spider communities. *Oxyopes javanus* acts as a hunting spider in both crops and wild plants, while the ground spider *Pardosa sp.* from the Lycosidae family is more representative of field ecosystems featuring similar crops and nearby wild plants. Öberg (2007) suggested in his study that Linyphiidae and Lycosidae are evenly distributed in fields or show a preference for newly planted areas. Most spiders are hunters, both in crops and on the ground, which corresponds with their prey. Lycosidae and Linyphiidae were the families identified in cultivated fields, exhibiting high spider species richness and abundance at each phase of corn cultivation. Duffey (1978) and Topa et al. (2021) suggested that Linyphiidae (Araneae), although present, is not affected by tillage activities.

Changes in spider species composition correlate with plant age development. Young corn plants possess a simple shape, while older plants exhibit more complexity. This complexity influences the presence, diversity, and richness of spider species, which is directly proportional to plant age growth, resulting in plots in the flowering phase of corn cultivation exhibiting high spider abundance and frequency. This could stem from the fact that cultivated fields allow the loss and reestablishment of ecosystems as crops and wild plants thrive. Repeated changes in microhabitats and relative resource availability affect spider communities, allowing disturbances to create new opportunities for certain species adapted to these conditions. Prieto-Benítez & Méndez (2011) indicated that spiders exhibit contrasting effects based on the ecosystem (edge effects), influencing spider species richness in agroecosystems. According to research by Prieto-Benítez & Méndez (2011) on the effects of soil cultivation on arthropods, spider species richness in agroecosystems is impacted by edge effects that have various implications depending on the ecosystem. The richness and abundance of spider species indirectly influence arthropod populations, particularly pests in corn crops. Spiders function as biological control agents in polyphagous crops (Riechert & Lockly, 1984), thus playing a role in maintaining ecosystem balance.

CONCLUSION

The diversity of spiders across various ecosystems includes 67 species found in corn crops from 17 families. Farming systems and the age of corn crops influence the number of species present. Land use affects the composition of spider species that coexist in environments, including intercropping and monoculture farming systems. Dominant species in corn crops in Bogor include ambusher spiders, *Oxyopes javanus*, and ground spiders, *Draposa tenasserimensis*.

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