RESEARCH PAPER

Spider Diversity and Ecologically Dominant Species Affect Crops through Predation

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ABSTRACT
This study investigates the impact of spider diversity and ecologically dominant species on insect pests in agricultural crops through predation. The researchers observed the feeding behavior, prey preferences, and predatory efficiency of dominant spider species on insect pests. The research, conducted in various crop systems, aims to understand the role of spiders in natural pest control within agroecosystems. By assessing spider diversity and abundance using pitfall traps and visual surveys, the study examines the predatory potential of key spider species on common insect pests. Laboratory experiments demonstrate that larger spiders capture more prey, with seasonal variations in web sizes impacting pest control potential. The study underscores the importance of conserving ecologically dominant spider species for sustainable pest management practices in agriculture.
Keywords: spider diversity, agricultural crops, pest control, sustainable, agriculture.
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INTRODUCTION
Cropsr diversity and the predation impact of ecologically dominant species on insect pests of crops play a vital role in “integrated pest management (IPM) systems” in agriculture. Spiders are versatile predators that have a crucial impact on controlling insect populations, leading to a decrease in the reliance on chemical pesticides and the preservation of ecological equilibrium in agroecosystems. The variety of spider species and their ecological dominance can greatly impact the efficiency of their predation on insect pests. The objective of this study is to examine how the variety of spiders and the presence of ecologically dominant species affect insect pests in different crop systems. Specifically, we will focus on the role of spiders as natural predators in regulating pest populations. Spiders can play a supplemental function in targeting different pest species or specific groups within the same pest species, so contributing to the natural biological regulation in agricultural ecosystems. While spiders' involvement in intraguild predation may limit their capacity to manage pests, a varied assemblage of spiders can nevertheless exert a significant influence on pest populations through top-down regulation (Saqib H S A et al., 2020). Insect herbivores have evolved a diverse range of protective strategies to safeguard themselves from predators. The traits of these organisms include a large physical size, a tough external covering, the capacity to camouflage, swift reflexes to escape threats, rapid reproduction, and a wide range of harmful chemical compounds to discourage their constant predators (van Bergen and Beldade 2019). The purpose of the study on spider diversity and ecologically dominant species in agro-ecosystems is to investigate the role of spiders as predators in agriculture.

MATERIALS AND METHODS

“Evaluation of predation attributes”
To evaluate the predation traits, a single spider species, which had abstained from eating for 12 hours before the experiment, was placed into a Petri dish. Subsequently, the spider was provided with a restricted, optimal, or abundant quantity of a particular insect pest as potential prey for the subsequent 24-hour period. This was conducted under the aforementioned controlled inanimate circumstances. The biomass of the spider, together with any remaining prey, was measured after a 24-hour period. For every type of spider's web, the investigation was repeated 10 times, prey environment, and insect pest type. To assess the natural decrease in biomass of the specific insect pest, which is the prey, within a 24-hour timeframe, we isolated the prey biomass under conditions of scarcity, optimal abundance, and high abundance. This was done separately for each condition, without any predators present, and under the specified abiotic conditions for 24 hours. The biomass of the prey was subsequently reweighed, and this procedure was iterated 10 times for every condition of prey availability, for each insect pest species under investigation, and for each species of carnivores. The expansion rate, degree of conversion, and ingestion percentage for every species of tarantula were determined

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using the methodologies derived from "Patel et al. (2018)".

$$\text{"Consumption rate (mg/day)"} = \frac{\text{"Prey biomass consumed by predator (mg)"}}{\text{"Feeding duration of predator (days)"}}$$

Statistical analyses
Before conducting further analysis, the experimental data underwent a check for homogenization of deviations using the Bartlett's test and the Kolmogorov-Smirnoff test for normalcy. A three-way ANOVA was used to examine the trophic factors, namely rates of growth and convert inefficiencies. Tukey's post hoc analysis of differences was used to examine the various rearing circumstances (ideal, plentiful, and scarcity) for several spider genera. "(O. javanus, P. sumatrana, T. javana, and N. theisi)", prey species, and their interactions as independent factors. The statistical program used for all statistical analyses was Minitab 16 "(Minitab Inc., State College, Pennsylvania, USA)".

RESULTS AND DISCUSSION

Influence of variations in prey-specific resources on the rate of utilization by four different kinds of spiders that live in wheat fields "(Values are Mean ± SE; different letters represent significant differences; F-values significant at $P < 0.05$)"

Experimental conditions	**Spider species**	**Consumption rate (mg-day^{-1})**	
		Sitobion avenae (Prey)	
		Wingless	Winged
Scarce	*Oxyopes javanus*	$2.86\pm0.06^{cC\beta}$	$2.72\pm0.05^{cC\alpha}$
	Pardosa sumatrana	$1.04\pm0.08^{bA\alpha}$	$1.38\pm0.06^{cA\beta}$
	Tetragnatha javana	$1.72\pm0.07^{bB\alpha}$	$1.68\pm0.06^{cB\alpha}$
	Neoscona theisi	$3.77\pm0.08^{cD\alpha}$	$3.84\pm0.07^{bD\alpha}$
Optimal	*Oxyopes javanus*	$2.31\pm0.16^{bB\beta}$	$1.62\pm0.18^{bB\alpha}$
	Pardosa sumatrana	$0.77\pm0.18^{aA\alpha}$	$1.12\pm0.07^{bA\beta}$
	Tetragnatha javana	$0.83\pm0.17^{aA\alpha}$	$1.42\pm0.09^{bB\beta}$
	Neoscona theisi	$3.03\pm0.16^{bC\alpha}$	$3.83\pm0.22^{bC\beta}$
Abundant	*Oxyopes javanus*	$1.71\pm0.32^{aB\beta}$	$0.86\pm0.15^{aB\alpha}$
	Pardosa sumatrana	$0.58\pm0.08^{aA\alpha}$	$0.43\pm0.09^{aA\alpha}$
	Tetragnatha javana	$0.67\pm0.09^{aA\alpha}$	$0.58\pm0.09^{aA\alpha}$
	Neoscona theisi	$2.03\pm0.21^{aC\beta}$	$0.92\pm0.13^{aB\alpha}$
Three-way ANCOVA			
Covariate		$F = 0.02$; $P = 0.898$; df = 1, 239	
Experimental condition (E)		$F = 214.87$; $P < 0.0001$; df = 2, 239	
Spider species (S)		$F = 51.45$; $P < 0.0001$; df = 3, 239	
Prey variants (P)		$F = 3.41$; $P = 0.066$; df = 1, 239	
Interaction (E×S×P)		$F = 5.16$; $P < 0.0001$; df = 6, 239	

To ascertain the important impacts of the growing circumstances, spider species, and how they interact on the predatory rates of carnivorous spiders, the current research used a three-way ANCOVA. Predator utilization rates, nevertheless, were not statistically significantly impacted by either the dependent variable or the changes in prey. According to Tukey's post hoc examination of means, the greatest proportions of consuming were when prey was scarce and lowest when prey was plentiful, regardless of the spider species. Moreover, the wingless morph exhibited increased consumption rates in comparison to the winged morph. Among the four spider species, N. theisi displayed the most elevated rates of consumption, with O. javanus and T. javana following closely after. Conversely, P. sumatrana exhibited the lowest levels of consumption. The findings of the three-way ANOVA revealed significant changes in the conversion efficiency and development rate of predaceous spiders, depending on the conditions in which they were raised, the species of spider, and the type of food they consumed. Nevertheless, there was no notable correlation between these characteristics. Irrespective of the type of spider, the analysis of averages revealed that both the conversion efficiencies and growth rates were at their peak when prey was scarce and at their lowest when prey was plentiful. The characteristics displayed a higher degree of magnitude in the wingless form compared to the winged form. As a result, web-building spiders have a reduced food intake, but they compensate for this by being very efficient, allowing them to overcome the limitation of a lower rate of consuming prey. Furthermore, it has been suggested that the diminished predation of aphids may be attributed to the emission of odoriferous substances by the aphids themselves (Omkar et al., 2009). The findings support previous research, suggesting that differences in the differences in prey size, amount duration spent dining on the prey, predator capture techniques, and physiological variations might all contribute towards the four-arachnid species' varying rates of intake. “(Butt and Xaaceph 2015; Memah et al. 2018)”.

CONCLUSION

Spiders exhibited the highest rates of consumption and growth while preying on insect pests of rice that were plentiful in number. Nevertheless, their conversion efficiency was most elevated when feeding on the limited availability of food. The four spider species being studied exhibited a greater consumption of prey biomass, specifically nymphs of L. varicornis, adult stages of leafhoppers, and lepidopteron pests, when compared to Leptocorisa adults and grasshopper nymphs

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