Does biodiversity affect Olive fly population? Evidence form different understorey treatments

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Introduction

Olive groves, a major cultivation in Mediterranean basin, faces increasing challenges from pests like the olive fly [*Bactrocera oleae* (Rossi) (Diptera: *Tephritidae*)]. To mitigate these threats and promote sustainable practices, understorey management emerges as a promising strategy. Understorey, the area beneath the olive trees, plays a pivotal role in fostering a diverse arthropod community. Native plants within this layer provide essential resources such as habitat, nectar, pollen, and prey for beneficial insects [1]. These insects, including natural enemies of the olive fly, help to maintain a balanced ecosystem and reduce the need for chemical interventions. Integrated Pest Management (IPM), a holistic approach to pest control, aligns with the principles of Conservation Biological Control (CBC). By preserving and promoting the populations of natural enemies, CBC can effectively manage pest outbreaks. Understorey management is a key component of IPM, as it creates favorable conditions for these beneficial insects to thrive. Bees, often overlooked in agricultural systems, play a crucial role in pollination and biodiversity. Olive groves with well-managed understories can provide suitable habitats for bees, enhancing their abundance and diversity [2]. The presence of bees can also serve as an indicator of overall ecosystem health. This study explores the relationship between understorey management, insect species richness, olive fly populations, and the potential for biological control. By monitoring land cover, temperature, and insect populations in olive groves on Lesvos, Greece, the researchers aim to shed light on the ecological dynamics of this important agricultural system.

Methods

The data presented were collected in the year 2021 and 2022 on the Island of Lesvos and the samplings had a duration of 28 weeks/year, starting from spring until autumn. The experimental plots are 15 olive groves treated with equal intensity at the tree level, while they differ in the management practices of the understorey. In 10 of them, the plant community was left undisturbed (Fig. 1), while in the remaining 5 it had been cleared with the use of mechanical means (Fig. 2). More specifically, olive fly population was monitored with McPhail traps. Pitfall traps were used to monitor arthropods on the ground, and pantraps for the flying insects. All samplings were performed with a weekly frequency. In addition, the temperature of the microclimate of the tree canopy was recorded using ibutton sensors.

Results

Undisturbed olive groves were found to have higher plant species richness and abundance compared to cleared groves. Several plant species were exclusively found in undisturbed groves, while others were more abundant there. Arthropod diversity was also significantly higher in undisturbed groves. Coleoptera were the most abundant arthropod group, followed by Hymenoptera, Diptera, and Formicidae. Ground arthropods and flying insects were both more abundant in undisturbed groves. Ground beetles and bees were particularly enriched in undisturbed groves. Both groups had higher species richness and abundance in these areas. Olive fly abundance was lower in undisturbed groves compared to cleared groves. Temperature had limited effects on most parameters. High temperatures positively correlated with flying insect abundance, while low temperatures negatively affected flying insect abundance and plant richness in cleared groves. Correlation analysis revealed positive relationships between plant richness and abundance, as well as between ground arthropod abundance and richness, bee richness and abundance, and flying insect abundance. Olive fly abundance was negatively correlated with plant richness and abundance.

Discussion

Undisturbed understorey management in olive groves positively impacts plant diversity, arthropod community, and olive fly populations. Plant richness and abundance were higher in undisturbed groves due to favorable microclimates and soil conditions. In contrast, cleared groves had higher annual plant abundance due to increased sunlight and reduced competition. Temperature did not significantly affect overall plant richness and abundance, but correlated with plant richness in cleared groves. Arthropod diversity was significantly higher in undisturbed understoreys, with higher populations of ground beetles, bees, and flying insects. This is attributed to the suitability of undisturbed habitats for various ecological roles. Ground beetles and bees were particularly enriched in undisturbed groves, with strong positive connections between their abundance and plant diversity. Olive fly populations were lower in undisturbed groves. The presence of a diverse arthropod community, including natural predators, likely contributes to this. Bees may indirectly benefit olive groves by promoting plant diversity and fostering a more abundant arthropod community. Extreme temperatures had limited effects on olive fly populations, suggesting their adaptability to heat stress. Undisturbed understorey management can be included in Integrated Pest Management (IPM) programs as a sustainable and biological alternative to chemical pest control. It promotes biodiversity and enhances habitats for natural enemies, contributing to a more sustainable olive production system.

Fig. 1

Fig. 2

Fig. 3

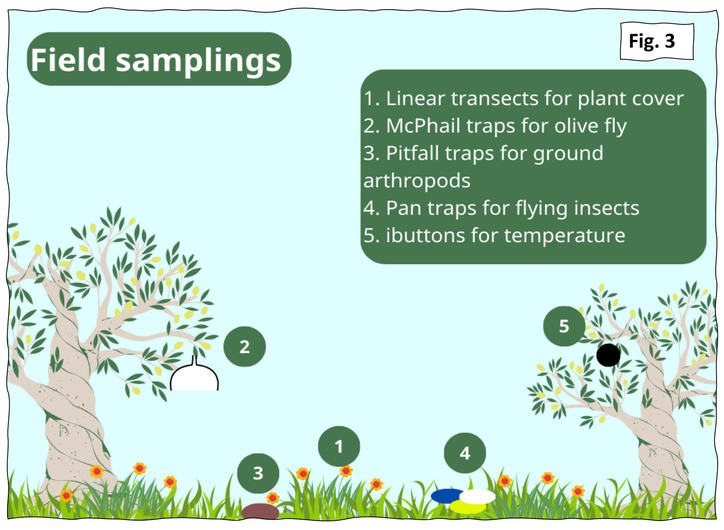

Fig. 4

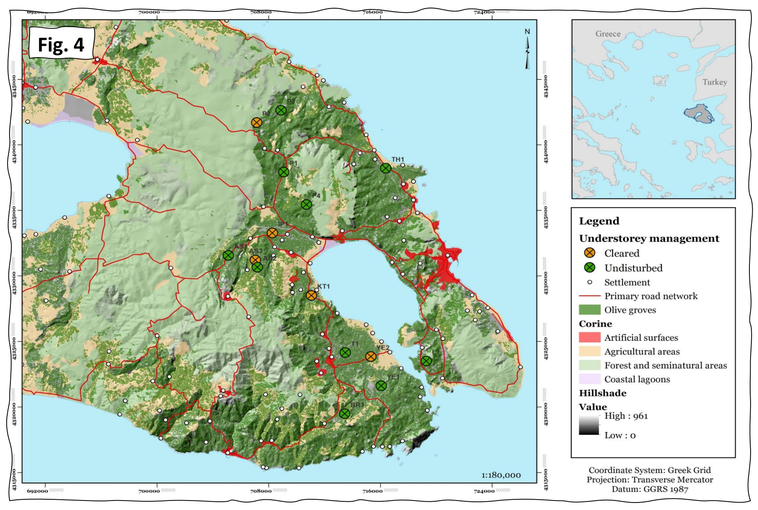

Fig. 5

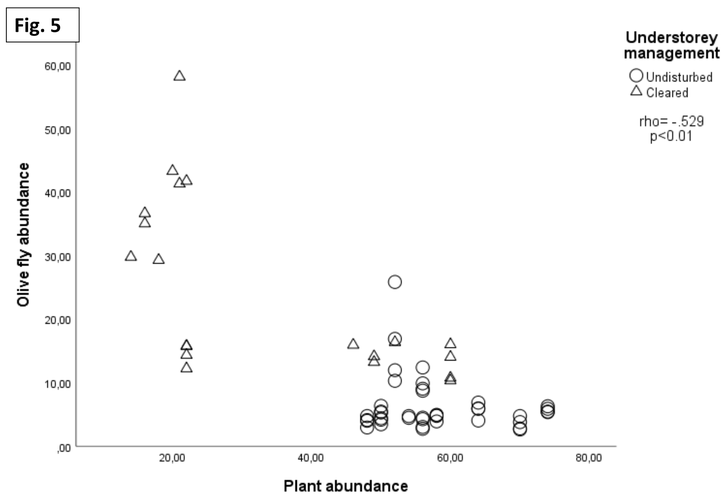

Fig. 6

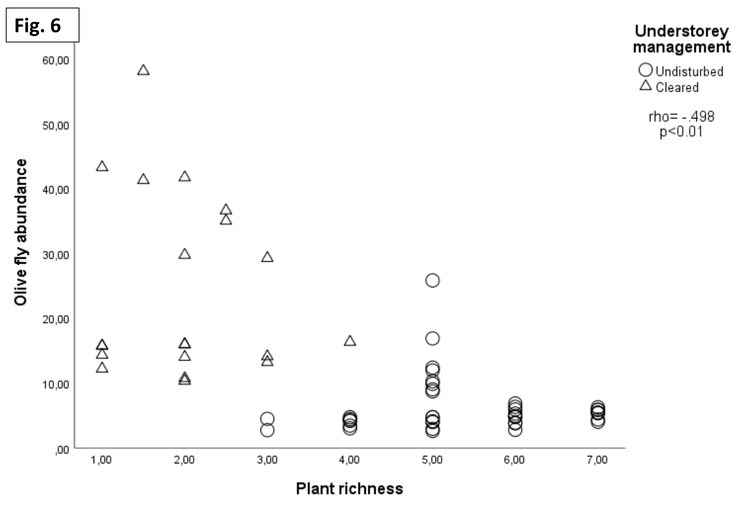

Table 1

		Ground beetle richness	Ground beetle abundance	Total ground arthropod abundance	Bee richness	Bee abundance	Flying insect abundance	Plant richness	Plant abundance	Olive fly abundance
Olive fly abundance	rho	-0.713**	-0.669**	-0.648**	-0.691**	0.653**	-0.631**	-0.498**	-0.529**	
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.003	
	N	450	450	450	150	150	150	450	450	
Plant richness	rho	0.707**	0.728**	0.828**	0.643**	0.706**	0.579**		0.623**	
	p	0.000	0.000	0.000	0.000	0.000	0.001		0.000	
	N	450	450	450	150	150	150		30	
Plant abundance	rho	0.538**	0.577**	0.661**	0.338	0.408*	0.564**	0.623**		
	p	0.002	0.001	0.000	0.067	0.025	0.001	0.000		
	N	450	450	450	150	150	150	30		
hours > 31 °C	rho	-0.086	-0.032	-0.024	0.024	0.039	0.266*	0.59	0.005	0.031
	p	0.456	0.654	0.425	0.758	0.742	0.020	0.456	0.521	0.723
	N	450	450	450	150	150	150	30	30	450
hours < 23 °C	rho	0.039	0.058	0.016	-0.048	-0.078	-0.232**	-0.012	0.034	-0.039
	p	0.345	0.462	0.349	0.842	0.674	0.001	0.342	0.349	0.741
	N	450	450	450	150	150	150	30	30	450

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Fig. 7

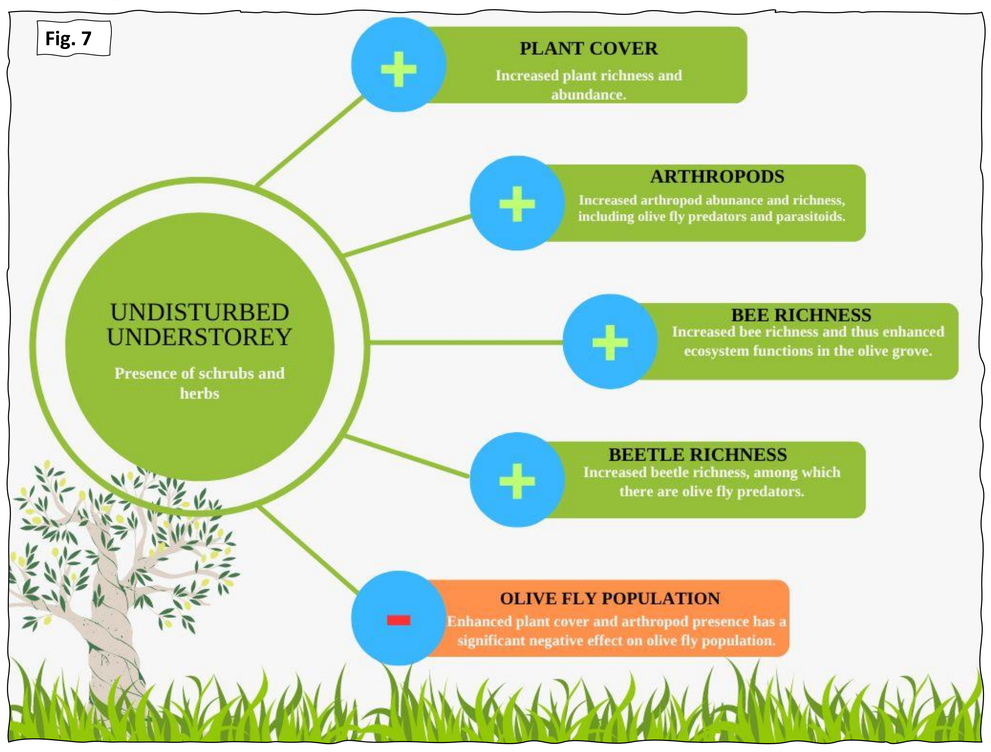

Fig.1 Traditional terraced olive grove
Fig.2 Olive grove with cleared understorey
Fig.3 Field samplings
Fig.4 The experimental plots on Lesvos Island
Fig.5 Scatterplot of relationship between olive fly abundance and plant abundance (Spearman's rank coefficient = rho)
Fig.6 Scatterplots of relationship between olive fly abundance and plant richness (Spearman's rank coefficient = rho)
Fig.7 Summary of the research results
Table 1 Spearman's Rank Correlation Coefficients (rho) for arthropod studied parameters, plant cover parameters and temperature indexes

Scan for more information

References

[1] Stavrianakis G, Sentas E, Stattegger SR, Tscheulin T, Kizos T (2024) Effect of olive grove's understorey management on arthropod diversity. Agroecology and Sustainable Food Systems, 48(8): 1115–1138. https://doi.org/10.1080/21683565.2024.2364739

[2] Martínez-Núñez C, Manzaneda AJ, Isla J, et al (2020) Low-intensity management benefits solitary bees in olive groves. Journal of Applied Ecology 57:111–120. https://doi.org/10.1111/1365-2664.13511

Photos: Giorgos Stavrianakis