The impact of soil management, agroecological zone, and season on ground-dwelling insects in Tunisian olive groves

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Introduction: Biodiversity is crucial for agriculture as it provides several ecosystem services, such as pest biocontrol, crop pollination, and soil health enhancement. However, studies have shown a significant global decline in biodiversity. Therefore, it is essential to investigate how agronomic practices can promote functional biodiversity to benefit both ecological and agronomic purposes.

Goal: To enhance the functional diversity of ground-dwelling insects in Tunisian olive groves by implementing various soil management practices.

Method: In 2022, insect diversity was monitored using pitfall traps in two Agro-Ecological Zones (AEZs) across three soil management practices during two key phenological stages of the olive tree: flowering and fruit ripening.

Insect abundance differences between AEZs, phenological stages, and practices were analyzed using one-way ANOVA, followed by an SNK post-hoc test.

Two AEZs:

Toukaber and Jammel

Three practices:

Tillage (farmer´s practice)

No-tillage

Faba bean cover crop

Insect community sampling:

Pitfall trap installation

Identification at order level

Results

1. Abundance: Hymenoptera, Collembola, and Neuroptera were found in greater numbers in Jammel, while Orthoptera, Blatoptera, Zygentoma, and Dermaptera were found in greater numbers in Toukaber (Fig.1).

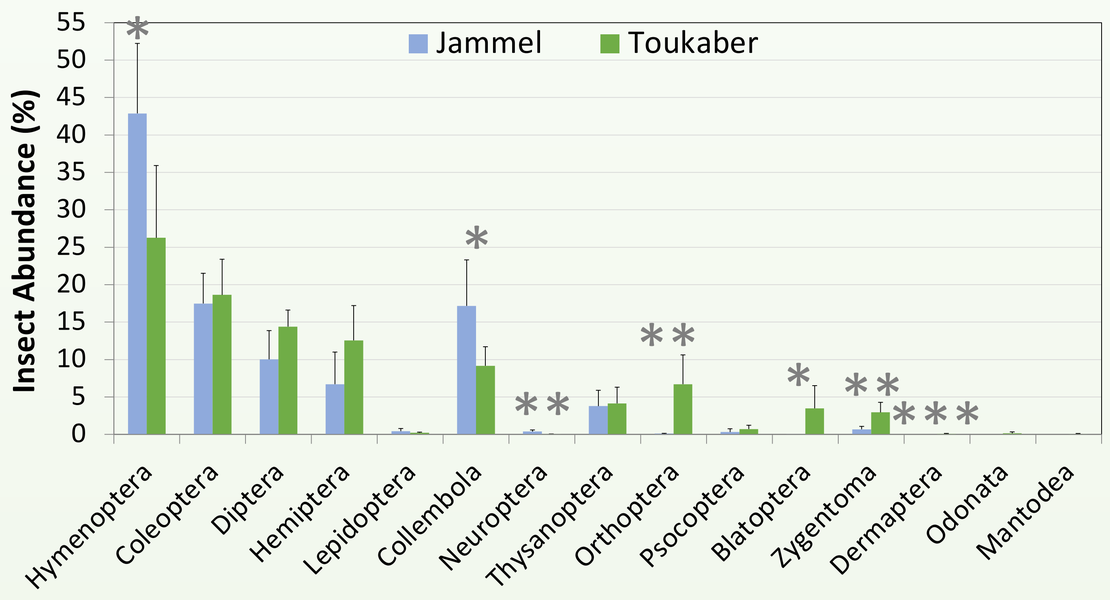

Fig.1. *Variation of insect abundance by order between two AEZs: Jammel and Toukaber. Statistical results from one-way ANOVA and SNK post-hoc test *: p<0.5, **: p<0.01, ***: p<0.001*

The abundance of ground-dwelling insects varied with the phenological stage of the olive trees. During flowering, Diptera, Hemiptera, Lepidoptera, Collembola, Neuroptera, Thysanoptra, and Dermaptera were the most abundant orders. In contrast, during fruit ripening, insects belonging to Hymenoptera, Blatoptera, and Zygentoma orders were significantly more prevalent (Fig.2).

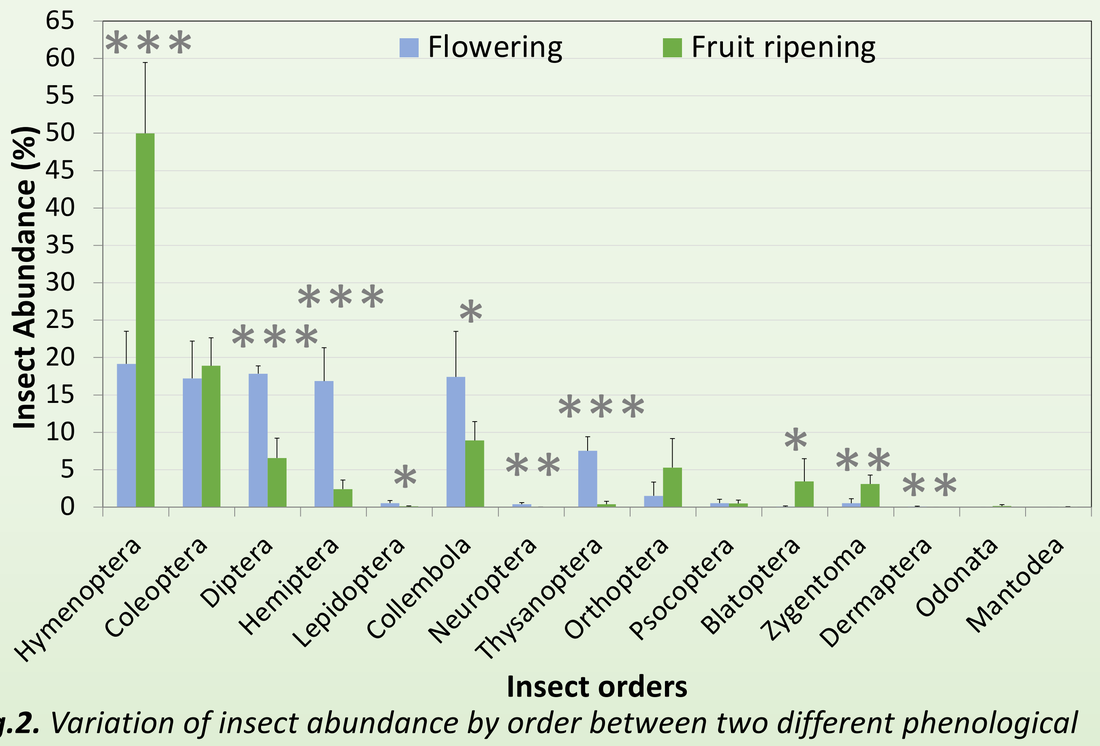

Fig.2. *Variation of insect abundance by order between two different phenological stage of the olive tree: flowering and fruit ripening. Statistical results from one-way ANOVA and SNK post-hoc test *: p<0.5, **: p<0.01, ***: p<0.001*

2. Diversity: During both flowering and fruit ripening, the number of insect orders was higher in Toukaber than in Jammel, regardless of tillage or no-tillage practices. However, under the faba bean cover crop practice, both AEZs had the same number of orders at flowering, while Jammel showed the highest order number at fruit ripening (Fig.3).

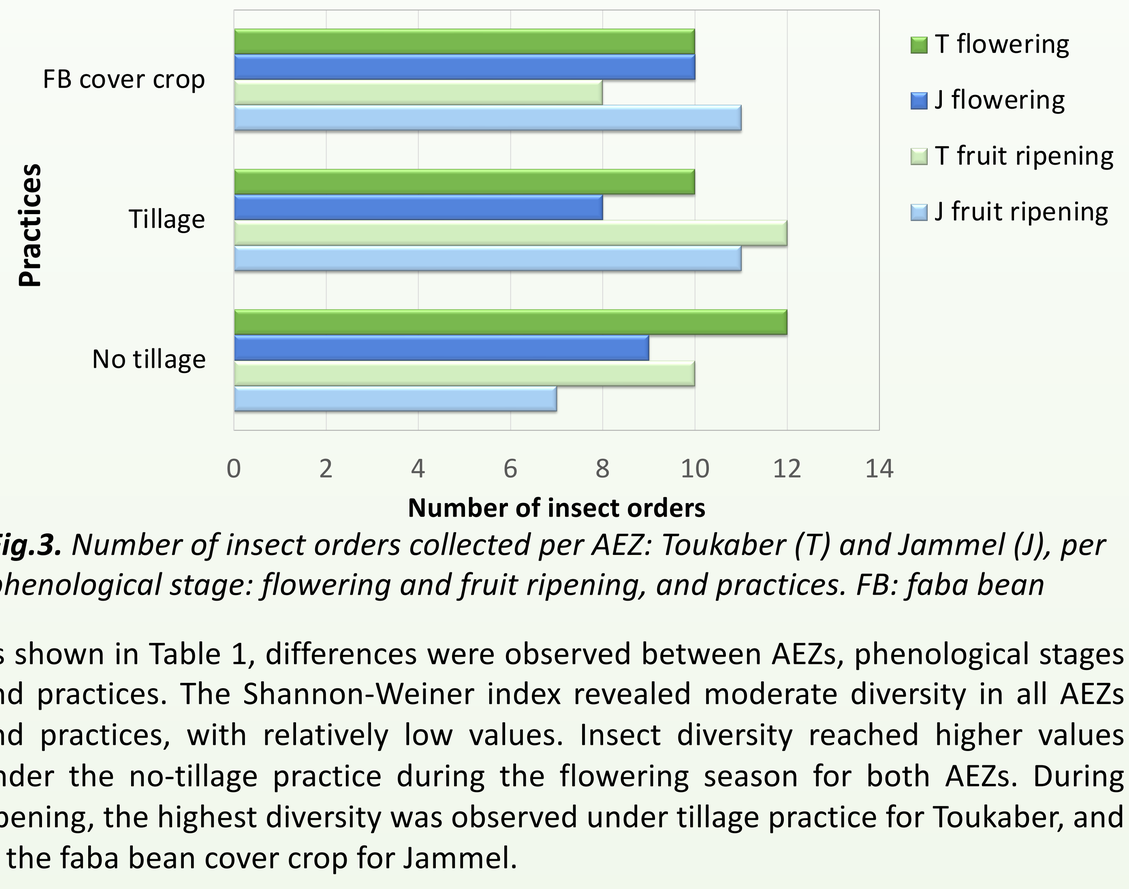

Fig.3. *Number of insect orders collected per AEZ: Toukaber (T) and Jammel (J), per phenological stage: flowering and fruit ripening, and practices. FB: faba bean*

As shown in Table 1, differences were observed between AEZs, phenological stages and practices. The Shannon-Weiner index revealed moderate diversity in all AEZs and practices, with relatively low values. Insect diversity reached higher values under the no-tillage practice during the flowering season for both AEZs. During ripening, the highest diversity was observed under tillage practice for Toukaber, and in the faba bean cover crop for Jammel.

Table 1. *Biodiversity indexes per AEZ, phenological stage, and practices. T: Tillage, N: No-tillage, FB: Faba bean cover crop. Bold: the highest value of Shannon (highest richness) and lowest value of Simpson (highest dominance).*

	Jammel						Toukaber					
	Flowering			Fruit ripening			Flowering			Fruit ripening		
	T	NT	FB	T	NT	FB	T	NT	FB	T	NT	FB
Shannon-Weiner index	1.74	**1.86**	1.51	0.99	0.88	**1.12**	1.74	**1.86**	1.78	**2.05**	1.76	1.16
Simpson index	0.38	0.35	**0.27**	0.46	0.51	**0.42**	0.19	0.19	**0.18**	**0.14**	0.22	0.48

The Simpson index indicated strong overall dominance of some orders across AEZs and practices, with consistently low values. The faba bean cover crop had the lowest Simpson index at flowering, where Collembola dominated in Jammel and Hemiptera in Toukaber. At fruit ripening, the communities with the highest dominance were found in Jammel's faba bean cover crop, dominated by Hymenoptera, and in Toukaber's tillage practice, dominated by Collembola.

Conclusions: The abundance and diversity of ground-dwelling insect orders in olive groves varied in both AEZs, phenological stages, and in response to soil management practices. The Shannon index revealed that diversity was highest under no-tillage during flowering, and in either faba bean cover crop or tillage treatments during fruit ripening, depending on the AEZ. However, communities exhibited high dominance, as indicated by low Simpson index values. Faba bean harbored communities with the highest dominance, particularly in Jammel, with Hymenoptera, Hemiptera, and Collembola being the dominant orders.

These identified orders can provide ecosystem services, such as Collembola contributing to soil structure and health. However, some orders encompass species providing both ecosystem services and disservices. Hymenoptera and Lepidoptera include pollinators, as well as biocontrol agents (Hymenoptera) and pests of the olive tree (Lepidoptera).

Further taxonomic identification at a lower level is essential to better investigate the influence of soil management practices on insect communities at key phenological stages and in both AEZs.