INTEGRATED WEED MANAGEMENT IN OLIVE ORCHARDS: INFLUENCE ON BIODIVERSITY, CROP PRODUCTION AND QUALITY

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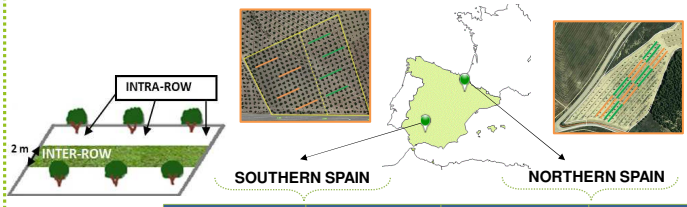
INTRODUCTION

Spain is the country with the largest olive growing area in the world. Soil management techniques aim to promote high profitability and quality production, being essential a proper weed control to prevent them from competing with olive trees for water, light, rooting space, and other mineral resources. However, the combination of a Mediterranean-type climate, sloping areas, and management practices with scarce herbaceous vegetation cover have led to severe problems of water availability and soil erosion over the years. Moreover, we are facing a growing problem of herbicide resistance, the expectation that many of the currently used herbicides will be withdrawn from the European market accompanied by the negative effects of herbicides on farmland biodiversity. The need to combine crop production with the protection of agroecosystem has sparked interest in using alternative weed control approaches focused on reducing the use of herbicides, replacing them, totally or partially, with non-chemical methods. According to the IWMPRAISE project "Integrated Weed Management: PRActical Implementation and Solutions for Europe", this study highlights the importance of using integrated weed management (IWM) techniques. A 2-year study with 4 IWM strategies was established and effects on the weed community and olive crop were evaluated, analyzing the richness, abundance and biodiversity, as well as the olive yield and quality.

MATERIAL AND METHODS

FIELD TRIALS:

4 IWM strategies that include two distinctive areas (inter-row and intra-row spacing) with different soil and weed managements:



	Strategy TL	Strategy GCC	Strategy NT	Strategy CCC
Inter-row spacing	Tillage + Pruning wood residues	Spontaneous grass cover crops (*Bromus* spp)	No tillage with chemical control	Sown crucifer cover crops (*Sinapis alba*)
Intra-row spacing		No tillage with chemical control + Pruning wood residues		No tillage with chemical control
Plot size	528 m² (11 x 48 m)		429 m² (13 x 33 m)	
Experimental design	Randomized complete block design with 4 replications			

ASSESSMENTS:

- **Weed flora:** the richness (nº of species), abundance (nº of plants·m^{-2}), diversity (Shannon index H') and equity (Pielou index J') were calculated from plant density data in 4 randomly selected 0.5 m² areas of each sampling area per plot before applying the weed control methods.
- **Olive yield** (Kg/ha)
- **Olive quality:** Fruit oil content, fruit moisture, fat content and acidity (%).
- **Statistical analysis:** Linear mixed effects models were used to test for differences between IWM strategies and were adjusted using the *lmer* function from the *lme4* library in the R environment. In all cases, the variable 'plot' was included as a random effect and the variables 'IWM strategy' and 'sampling area' were included as fixed effects. The statistical significance of the effects was obtained by *ANOVA* and *Tukey* test ($P < 0.05$).

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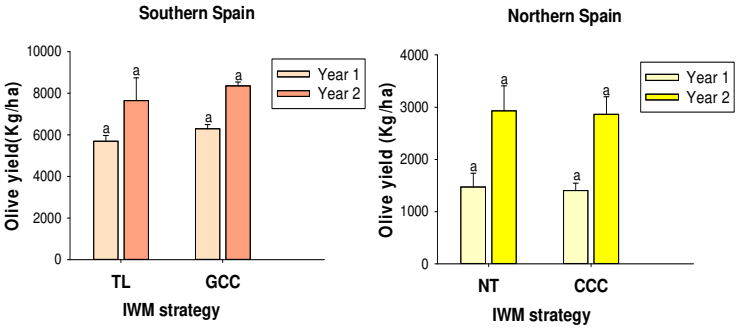
RESULTS AND CONCLUSIONS

This study showed that the different IWM strategies had an effect on the weed community. Results showed a greater richness, abundance and diversity in the CC intra-rows than TL, as well as a greater richness and diversity in the CC inter-rows in southern Spain. In northern Spain, a greater richness was observed in the NT inter-rows, but diversity and equity indices only showed significant differences in the CC intra-rows the year 2:

			Richness (nº of species)		Abundance (nº plants·m^{-2})		Diversity (Shannon index)		Equity (Pielou index)	
			INTER	INTRA	INTER	INTRA	INTER	INTRA	INTER	INTRA
Southern Spain	Year 1	TL	5 b[1]	5 b	24 a	25 b	0.97 b	0.95 b	0.60 a	0.53 a
		GCC	12 a	12 a	23 a	50 a	1.91 a	1.59 a	0.78 a	0.68 a
	Year 2	TL	3 b	2 b	24 a	13 b	0.49 b	0.32 a	0.63 a	0.69 a
		GCC	6 a	7 a	24 a	286 a	1.05 a	0.69 a	0.65 a	0.30 a
Northern Spain	Year 1	NT	12 a	10 a	1684 a	148 a	1.26 a	1.24 a	0.51 a	0.55 a
		CCC	9 b	8 a	2346 a	151 a	0.89 a	1.14 a	0.41 a	0.55 a
	Year 2	NT	15 a	10 a	1436 a	79 a	1.29 a	1.29 b	0.47 a	0.56 b
		CCC	11 b	11 a	1557 a	106 a	1.13 a	1.60 a	0.48 a	0.68 a

Yield and quality results were not affected by the IWM strategy at any location, despite the greater existence of herbaceous vegetation cover in the inter-rows of strategies GCC and CCC:



		Fruit oil content (%)		Fruit moisture (%)		Fat content (%)		Acidity (%)	
		Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Southern Spain	TL	21 a[1]	18 a	47 a	51.3 a	39.2 a	37 a	0.39 a	0.47 a
	GCC	20.5 a	16.8 a	48.5 a	54.8 a	39.8 a	37.2 a	0.43 a	0.36 a
Northern Spain	NT	28.3	23.4 a	38.9	43.3 a	46.4	41.3 a	0.44	0.33 a
	CCC		23.1 a		42.9 a		40.5 a		0.32 a

These preliminary results indicate that the introduction of IWM in olive orchards makes it possible to reconcile crop production and weed biodiversity without harming olive yield and quality. Further research on the factors influencing the emergence and proliferation of species could improve the weed control efficacy, favoring a transition to a more sustainable system.