Congreso Internacional sobre Agricultura de Conservación

El reto de la Agricultura, el Medio Ambiente, la Energía y la nueva Política Agraria Común

Córdoba (España)
9-11 de Noviembre de 2005

Editan:

ASOCIACIÓN ESPAÑOLA AGRICULTURA DE CONSERVACIÓN / SUELOS VIVOS
FEDERACIÓN EUROPEA AGRICULTURA DE CONSERVACIÓN
DIPUTACIÓN DE CÓRDOBA

Coordinadores:

Oscar Veroz González
Antonio Holgado Cabrera
Rafaela Ordoñez Fernández
Emilio J. González Sánchez
Jesús A. Gil Ribes

Diseño, Maquetación y Fotomecánica: Casares, S.L.
I.S.B.N.: 84-930144-4-3
Depósito Legal: CO-1272-05
Imprime: Argos Impresores, S.L.

Plant covers for the conservation management of a dry farmed olive and vine orchards on the arid degraded soils of central Spain

PASTOR, J.[1]; HERNÁNDEZ, A.J.[2]

[1] Dpto. Ecología de Sistemas, CCMA, CSIC,
Serrano, 115. 28006 Madrid. España.
[2] Dpto. Interuniversitario de Ecología, Sección de la Universidad de Alcalá (Madrid)
Edificio Ciencias, Campus.

Summary

Herein we describe the 8-year results of an ongoing investigation performed in a vine and an olive orchard on the same farm from a perspective of conservation management. The main approaches explored were seed bank management, the use of stable, yet managed, plant covers to provide a fertile base, and promoting the self-functioning of the farm by circulating cut hay from the olive crop to the vineyard and by incorporating pruning remnants into the soil. Plant covers not only produce a natural fertilizer but also play an important role in controlling the weeds typical of these two woody crops. Results so far include increased soil organic matter and biological activity, as well as diminished erosion. In addition, we have been able to establish the time frames necessary to initiate a rotation system for the measures adopted, aimed at avoiding competition for water with the crops on behalf of the plant covers.

Key words: seed bank management; weeds, vetch, subclover covers; wild legumes; hay transfer.

Introduction and objectives

Initial results after the change in land use from a traditional agricultural farm towards a more sustainable type of agriculture were obtained in some hectares devoted in the past to cereal crops and now used as pasture land for sheep (Hernández & Pastor, 1994). The benefits of managing the native flora present in the seed bank

have become apparent despite over 50 years of cultivating barley. These benefits include the control of soil erosion, addition of organic matter and green amendment supplied by the legumes resident in the seed bank. Exploiting these aspects were the main issues assessed in this 8-year investigation (1997-2004) performed on two woody crops cultivated on the same farm and subjected to traditional tillage management or non-tillage along with the use of herbicides. In this report we present a summary of the results to give an overall picture of the strategies used to manage the soil bank aimed at establishing stable plant covers. The final aim was to achieve a fertile base and promote the self-sufficiency of the system by recycling hay from the olive orchard for use in the vineyard and incorporating pruning remnants into the soil. We consider these types of measures for non-irrigated crops are a form of conservation management.

Materials and Methods

The olive and vine orchards are situated in the experimental farm "La Higueruela" (Toledo, central Spain), which belongs to the Spanish Research Council, the CSIC. Our experiment was designed to explore two main overlapping areas: a) soil and biodiversity conservation in the olive orchard and vineyard and b), promoting the growth of plant covers ("weeds" and leguminous species) and managing these covers under the limited rainfall regime of the Spanish Mediterranean dryland region. The characteristics of the farm and the experimental design may be found in Hernández, Lacasta & Pastor (2002). Table 1 shows the different management strategies

TABLE 1
MANAGEMENT SYSTEMS APPLIED

Olive orchard	Vineyard
(a) *Vetch cover (Vicia sativa).* This legume was grown from commercially available seeds in November. At the time of flowering, the vetch was mechanically trimmed to avoid it competing for water, while the plant remnants were left on the soil until their burial in mid-spring.	(a) *Subclover cover.* As described for the olive crop.
(b) *Subclover cover (Nungarin, Daliak and Esperance cultivars).* This species was considered suitable for the soil properties established for the plots in the autumn of 1997. Seeds of cultivars of different biological cycle length were sown inoculated with *Rhizobium trifolii.* In this trial, weeds were left to grow alongside the subclover.	(b) *Weed cover.* As described for the olive crop.
(c) *Weed cover.* The soil was left untilled allowing the species in its seed bank to grow freely. These weeds were mechanically cut back in the middle of each spring.	(c) *Tillage + incorporating pruning remnants into the soil.*
(d) *Non-tillage plus herbicides (glyphosate and simazine).* Plots already managed in this way for several years were incorporated into the study. We also included plots subjected to conventional tillage as controls.	(d) *Non-tillage plus herbicides (glyphosate and simazine).* As described for the olive crop.
	(e) *Recycled weed cover.* The mowed native legumes of treatment (c) applied to the olive crop were incorporated into the soil of the (b) vine plots after the fourth year of the trial. This measure was designed to enrich the soil by providing the seed bank with new species.

explored in each of three plots randomly distributed in the vine/olive orchards. Cover values for the different plant species were recorded in spring.

Results and Discussion

Based on the findings of a previous study in which we examined the ecological and soil conditions of each crop, we selected two commercially available legumes for use as a green amendment: vetch (*Vicia sativa*), and a mixture of early and late ecotypes of subclover (*Trifolium subterraneum*) to try to improve soil N and organic matter (OM) (Pastor, Lacasta & Hernández, 2000). During this preliminary investigation, we also decided to propitiate the growth of creeping legumes (*Ornithopus compressus* and *Biserrula pelecinus*) that started to spontaneously arise from the seed bank in the soil of the olive plantation in plots that were being managed by establishing weed covers (Hernández, Prieto & Pastor, 2001). The use of plant covers has been a complete success both using sown species (clover and vetch in the olive orchard and clover in the vineyard) (Pastor & Hernández, 2001), and promoting the growth of weeds resident in the soil seed bank. The species mentioned went from initially growing as isolated patches to achieving a high proportion of cover. The results provided in table 2 correspond to two years of similar mean annual rainfall (615 mm and 620 mm respectively for the first and eighth year of the experiment). To the abundance of these legumes, we would have to add the benefits of their persistence and plasticity or flexibility when confronted with climatic difficulties. These covers diminish in dry years but manage to recover in years of greater humidity (Hernández, Lacasta & Pastor, 2005).

TABLE 2
GENERAL BALANCE OF THE COVER PROVIDED MAINLY BY LEGUMINOUS SPECIES (WEEDS) IN OUR OLIVE AND VINE ORCHARDS (MEAN PERCENTAGES). THE + SIGN INDICATES PRESENCE ONLY. (WC = MEAN COVER VALUES RECORDED FOR THE WEED COVERS; SC = MEAN COVER VALUES RECORDED FOR THE SUBCLOVER COVERS)

Species	OLIVE				VINE			
	1st year		8th year		1st year		8th year	
	Wc	Sc	Wc	Sc	Wc	Sc	Wc	Sc
Ornithopus compressus	+	-	45	7	-	-	17,3	11,3
Biserrula pelecinus	+	-	25	6	-	-	10	2,7
Lupinus angustifolium	-	-	0,6	-	0,8	-	+	-
Trifolium arvense	+	-	1	0,3	-	-	8,3	1,7
Trifolium subterraneum	-	14	1	30	-	60	10,7	36,7
Other legume sps.*	2	2	2	2	<1	<1	2	2
Diversity (Nº sp)	73	51	58	46	73	44	69	53

*Other legume species appearing are: *Lathyrus angulatus, Medicago polymorpha, M. rigidula, Trifolium angustifolium, T. campestre, T. cernuum, T. glomeratum, T. hirtum, T. tomentosum, Trigonella polyceratia* and *Vicia bengalensis.*

The plots with permanent subclover covers have been a "substrate" for the development of an entire plant community that has invaded adjacent plots subjected to different treatments, especially the vineyard plots. This clover has gradually and spontaneously become installed in these plots to become a significant component of the existing plant cover, and was even able to recover its high proportions one year after another extremely dry year.

The plant covers established in the plots were able to efficiently impede soil erosion and also served to recover the biodiversity of weed species that owing to 50 years of traditional practices were scarcely present in these systems. Table 3 shows the plant cover values achieved by these species.

TABLE 3
OVERALL PLANT COVER (MEAN %) DETERMINED AT THE BEGINNING AND END OF THE EXPERIMENTAL PERIOD IN VINE AND OLIVE CROPS

Plant covers	OLIVE		VINE	
	Beginnig	End	Beginnig	End
"Weeds" cover	69	89,7	47	60
"Subterranean clover" cover	51	83,5	90	90,7

By adding pruning remnants to the soil surface of the woody crops, the physical space available for the colonization and growth of native species is restricted, especially in the olive orchard. Nonetheless, we were able to establish from our last analytical data that in the first 5 cm of soil, the proportion of OM has increased from initial values of 0,3-0,4% to values approaching 2% in plots that also have plant covers. This effect was much less appreciable in the tilled soils.

The use of covers comprised of spontaneous vegetation and subclover accompanied by the practice cutting back the tall weeds, along with the predominance achieved by legumes has also reduced the abundance of the weed species proper to these crops. This was not achieved during the first two years of management, but a significant controlling effect was observed after the third year of the plant covers. This finding is consistent with the known ecological succession of grass communities that takes place in these soils developed on arkosic substrates.

The addition of hay from managing the olive plantation to the vine plots with weed covers, besides expediting the creation of a native leguminous cover, has also helped mitigate erosion and the initial development of the undesired weeds already present in the seed bank of these plots.

Conclusions

In a short space of time, by naturally managing the seed bank (no use of herbicides) present in the plantations of these woody crops, we have achieved some impressive

cover values, including a high proportion of creeping native legumes in these rainfed systems. The consequence of this has been improved soil fertility and plant biodiversity.

Aknowledgements

This study was supported by the Comunidad de Castilla-La Mancha.

References

HERNÁNDEZ, A. J. & PASTOR, J., 1995. Gestión ecológica de la finca tradicional agrícola: experiencias para un proceso de transformación. En *Prácticas ecológicas para una agricultura de calidad*, pp. 100-109. Consejería de Agricultura y Medio Ambiente & SEAE, Toledo.

HERNÁNDEZ, A. J.; PRIETO, N. & PASTOR, J., 2001. Management of an olive crop in a semiarid environment using sown or resident leguminous covers. In *Conservation Agriculture, a Worldwide Challenge*, pp. 419-424. Eds L Garcia-Torres, J Benites & A Martinez-Vilela, ECAF & FAO, European Conservation Agriculture Federation, Madrid.

HERNÁNDEZ, A.J.; LACASTA, C. & PASTOR, J., 2002. Assessment of integrated soil conservation and improvement treatments for olive and vine crops in semiarid environments. In *Man and Soil at the Third Millennium*, pp. 2141-2153. Eds J L Rubio, R P C Morgan, S Asíns, V Andreu. Geoforma Ediciones, Vol II, Spain.

HERNÁNDEZ, A. J.; LACASTA, C. & PASTOR. J., 2005. Effects of different management practices on soil preservation and soil water in a rainfed olive orchard. *Agricultural Water Management* (in press).

PASTOR, J.; LACASTA, C. & HERNÁNDEZ, A. J., 2000. Evaluación de las cubiertas vegetales en el olivar de una zona semiárida del centro de España. *Edafología* 7:165-175.

PASTOR, J.; & HERNÁNDEZ, A. J., 2001. Empleo de cubiertas de trébol subterráneo en olivar y viñedo frente al laboreo y no laboreo en estos agrosistemas. En *Pastos, Desarrollo y Conservación,* pp. 721-727. SEEP, CSIC, Granada.