Using legume-grass commercial seed mixes to improve pasture of dehesa farms: production, persistence and diversity

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Abstract

Pasture improvement using legume-grass commercial seed mixes is a common practice in dehesa farms to increase pasture productivity for livestock production. Normally, the introduction of these mixtures is carried out after previous tilling of the land and basal dressing, mainly with phosphorus. The persistence of the introduced species, and their effect on pasture diversity at plot scale, has not received much attention. This study aims to analyse the effectiveness of this approach to improve the productivity of the pasture and its effect on plant diversity. The study was carried out on two dehesa farms from the south of Spain devoted to beef cattle. Natural pasture and sown pasture with legume-grass commercial seed mixes sown in 2017 were sampled during spring of 2019 to assess: (1) persistence of introduced species, (2) biomass production and (3) plant diversity. Sown pasture showed more herbage yield than natural pasture at least two years following the sowing. Most of the introduced species were present after two years of seeding but their abundance was low. The sowing of pasture had little effect on native plant diversity.

Keywords: annual grassland, species composition, grazing, intensification, Spain

Introduction

The dehesa is a savanna-like ecosystem that covers 3 million hectares in the Iberian Peninsula. The main human activity in this ecosystem is livestock breeding (Fernández-Rebollo *et al.*, 2008). This relies heavily on grassland production (Porqueddu and González, 2011). In recent years, sowing of legume-grass commercial seeds by dehesa farmers has increased, with aims of improving grassland performance to sustain the livestock feeding. The seeds of the most of the available annual grassland species are selected and multiplied mainly in Australia. However, these cultivars have often been poorly adapted to the complexity of management systems and variable climatic conditions (Salis *et al.*, 2012). Sowing in the dehesa grassland might also have a negative effect on plant diversity, given that the relationship between production and diversity is hump-shaped, with richness first rising and then declining with increasing productivity (Fraser *et al.*, 2015). The objectives of this study were to: (1) assess the persistence of the sown species after two years; (2) assess the sowing effect on biomass production, and (3) compare the plant diversity of the sown and natural dehesa grasslands.

Materials and methods

The study was carried out in two dehesa farms devoted to beef cattle located in the north and north-west of Andalusia (Spain). This area has a typical Mediterranean climate with long and dry summers. The annual average rainfall is 784 and 560 mm at the first and second locations, respectively. Soils are acidic, with a loamy-clay soil texture at the first location and loamy-sandy at the second.

In autumn 2017, on each farm, a large field (between 20-30 ha) was sown with a mixture of seeds after previous tillage and fertilisation with 150 kg ha^{-1} of lime superphosphate (18% P_2O_5). The legume-grass seed mix was composed of: *Lolium multiflorum, Ornithopus sativus, Ornithopus compressus, Trifolium incarnatum, Trifolium michelianum, Trifolium resupinatum, Trifolium subterraneum,* and *Trifolium vesiculosum.* After sowing, the pasture was grazed at low intensity at the end of winter and during summer. Grazing was restricted during the spring to allow flowering and seed production. In the second year after sowing, sampling was carried out on the two improved fields and two adjacent natural pastures, all of them reserved for summer grazing. In each field (sown and natural pastures) from both farms, at the end of November, February and May, twelve sampled quadrats of 0.4×0.4 m, placed around three points, were clipped to assess pasture yield (DM). Sampled biomass was oven-dried at 60 °C for 48 h and then, weighed for dry matter determination. In the May sampling, the biomass was manually sorted into the different species before drying, to assess species composition as yield proportion. Diversity was computed through species richness (S) and Shannon-Wiener Index (H). Additionally, curves of species accumulation were computed in EstimateS software following the interpolation method proposed by Colwell *et al.* (2012). ANOVA was performed to compare pasture yield between fields (sown and natural pasture), considering sowing as a fixed factor, locations as a random factor and the interaction of both factors. Pearson correlations were performed to assess the relationship between yield and plant diversity.

Results and discussion

Sown pasture exhibited higher production than natural pasture in spring ($P<0.05$) (Figure 1). However, production reached similar levels in autumn and winter. Pasture herbage production (natural and sown) of the farm located in the more humid environment (higher precipitation and loamy-clay soils) was also higher. Most of the sown species were registered during the sampling, although their abundance, expressed as a percentage of biomass, was low. The sown species that persisted after two years were *T. subterraneum, T. vesiculosum, O. compressus, O. sativus, T. michelianum and L. multiflorum.* Sown species contributed 6% to the total DM of spring sampling, of which 3% were legumes and 3% grasses.

The average number of species was 53 in natural pasture, and 49 in sown pasture. Figure 2 shows species richness per type of pasture for each location (derived from curves of species accumulation for n=12). Natural pasture hosted more species than the sown pasture on the farm located in a more humid environment, whilst it was the opposite for the farm with lower precipitation and sandy soils. Concerning the H index, the mean value was 2.66 and 2.50 for natural and sown pasture respectively. In both locations, H index of natural pasture was higher than that of sown pasture. Furthermore, H index of pasture with most precipitation was lower. There was no significant correlation between production and diversity (Pearson coefficient R=-0.12 and -0.09 for H and S respectively). Nevertheless, in the location of lower rainfall, we found a positive significant correlation between S and DM (Pearson coefficient R=0.46).

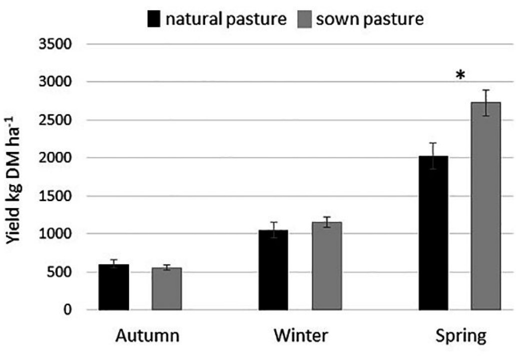

Figure 1. Dry matter (DM) of natural and sown pastures at each sampling date. An asterisk denotes a significant difference between natural and sown pastures ($P<0.05$).

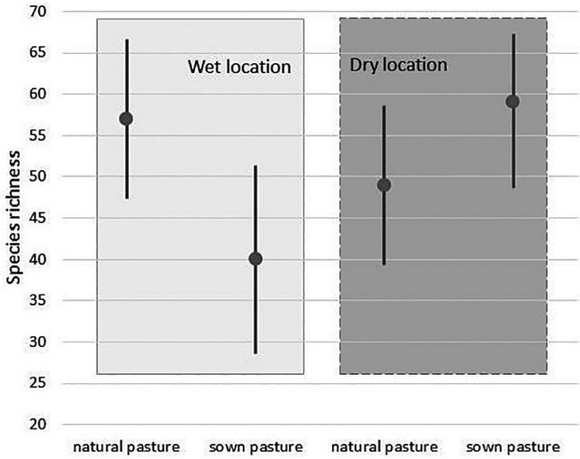

Figure 2. Mean of species richness of vascular plants at each location according to the type of pasture. Lines represent the 95% confidence interval.

Conclusions

The introduction of new pasture species in dehesa farms increased grassland production for at least two years following the sowing. Most of the introduced species were present after two years of seeding but their abundance was low. The sowing of pasture had little effect on native plant diversity. These results show that pasture improvement through the introduction of new species/varieties is possible in the dehesa system, with minimal impact on pasture diversity. However, it should be clarified whether similar increases in productivity can be obtained with other types of improvement, such as phosphoric fertilisation, which is less costly for farmers. More experimental work on farms is necessary in order to reach sound conclusions.

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