Simulating the effect of light availability reduction on grass and legume swards in a Mediterranean rainfed plot trial

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Abstract

Agroforestry (AF) is defined as the integrated management of woody species on croplands or grasslands and it is indicated as one of the farming systems with the greatest potential for climate change mitigation and adaptation (Kay et al. 2019). In Italy, agroforestry systems cover an area of 1.4 millions ha mainly based on silvoarable system with high value trees and agro-silvo-pastoral systems (Paris et al., 2019). In Tuscany, a typical silvoarable system consists in silvoarable olive grove intercropped with a low-productive natural pasture, usually not grazed, until the early-summer period when shallow tillage is performed in order to decrease water competition between herbaceous plants and trees (Mantino et al., 2016). Growing legumes, and in particular perennials legumes, under the canopy of tree crops could be a practice to improve sustainability of Mediterranean AF systems mainly by increasing the Nitrogen (N) content in the soil through symbiotic N_2 fixation, thus reducing the reliance on mineral N fertilisers (Anglade et al., 2015; Hernandez-Esteban et al., 2019) and enhancing soil cover protection (Vallebona et al., 2016). The most important perennial legume crop in Mediterranean area is alfalfa (*Medicago sativa* L.*)*. The effect of tree presence on legumes has been evaluated by several studies, reporting negative effects on yield, due to lower water availability (Nasielski et al., 2015), and reduced light availability (Gea-Izquierdo et al., 2009; Moreno et al., 2007), respect to an open field. Despite this, it was reported that the alfalfa nutritive value is not negatively affected by tree presence (Mantino et al., 2016). In Tuscany, the biennial legume Sulla (*Hedysarum coronarium* L.) could be interesting for its rusticity, productivity, and quality of the forage. Nevertheless, there is still a lack of knowledge on how the reduced light availability affects the development, the biomass accumulation and quality of forage species. Therefore, a rainfed plot trial was designed with the goal of investigating the effect of reduced light availability on Mediterranean legumes and grasses forage species. In October 2019, the plot trial was established at the Centre for Agro-Environmental Research "Enrico Avanzi" of the University of Pisa, San Piero a Grado (Pisa) (43°41'6.97"N 10°20'29.22"E), on a clay-loam soil with 2.5 % w/w of organic matter content in the topsoil (0 - 0.3 m) and 8.1 pH. Before sowing, performed on October 21st, 100 kg ha^{-1} of P_2O_5 were broadcast applied as triple superphosphate. The sowing was carried out on October 21th. The experimental layout complies with a two factor completely randomized block with four replicates (18 m^2 sizing each plot). One factor includes five levels assigned to five different swards: i) sulla cv. Silvan, (ii) ryegrass (*Lolium multiflorum* L. cv. Teanna), (iii) mix of sulla cv. Silvan and ryegrass, 50:50 (iv) mix of sulla cv Silvan, sulla cv. Chiara Stella and sulla cv. Avorio 33:33:33 and (v) alfalfa cv. Messe. Second factor has three increasing shading levels:

S0) the control representing full light availability, S25) and S50), corresponding to a reduction of potential light availability of 25 and 50% respectively. Shading was provided by woody slats, north-south oriented, 2.0 m long and 0.10 m wide, with a distance between each slats of 0.10 m for S50 and 0.20 m for S25, covering a total surface of 4 m^2. Slats were placed at 80 cm above ground level after the sowing (Fig.1). Light availability over and under the swards canopy is monthly measured by means of the SunScan (Delta-T Devices Ltd, Cambridge, UK) multiprobe sensor. Preliminary data showed no significant effect of shading treatments on seedling emergence for all the evaluated swards. Data about yield and nutritive value of herbage biomass, below-ground biomass and N$_2$ fixation will be evaluated for the next two years. This study received funding from the Tuscany Region Rural Development Plan, PINDARICO project - Measure 16.2 - 2017.

Figure 1. Slats placed immediately after sowing (Photo by L.G. Tramacere, 2019)

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