

Light intensity affects N-fixation and forage performances of legume swards in a Mediterranean agroforestry system

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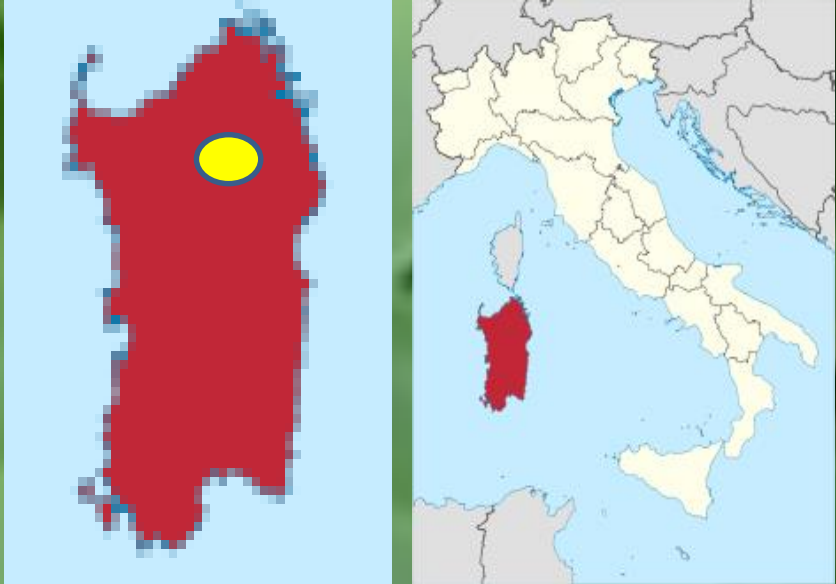
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Re G. A. Piluzza G., Sanna F., Campesi G., Sassu M. M., Stangoni A. P., Dettori D., Sulas L.
National Research Council, Institute for the Animal Production System in Mediterranean Environment, Sassari, Italy

INTRODUCTION

Mediterranean agroforestry systems integrate livestock and forage crops and might benefit from legume establishment, in terms of productivity and sustainability



GENERAL OBJECTIVES

Increase knowledge regarding the legume response and performances, at both sward and species level, to different conditions of light intensity, when grown beneath cork oak trees or fully exposed to solar radiation in open spaces of woodland

SPECIFIC OBJECTIVES

- Evaluate the potential of forage production and its quality
- Quantify N fixation ability of different legume based swards
- Investigate trait variations in legume plants

MATERIALS AND METHODS

A field experiment was carried out during 2015-16 in a private farm (40°37'99"N, 9°15'33"E, elevation 700 m a.s.l.) located in North East Sardinia (Italy). The climate is Mediterranean with hot dry summer. Long-term rainfall is 840 mm and average annual temperature is 12.7 °C

Partial shade conditions P.A.R. 15 – 30% (PS)

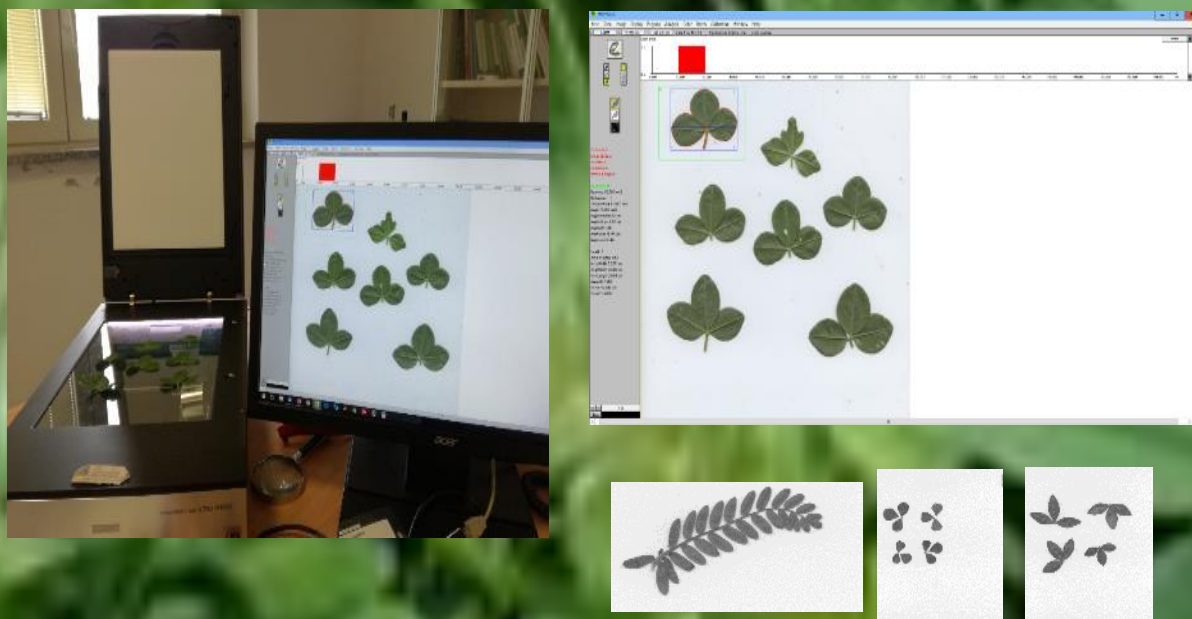
Full sunlight conditions P.A.R. 100% (FS)

The area is characterized by extensive agro-silvopastoral systems, with a representative Mediterranean evergreen cork oak woodland at a density of 450 trees ha⁻¹

Legume based swards

- **L100MIX** (Fertiprado: 100% legume species)
- **L80GMIX** (CNR-ISPAAM: 80% legume species and 20% grasses)
- **100BCLO** (*Trifolium spumosum*, 100%)
- **L60SNPA** (Unsown species: 60% legumes and 40% non legume species)

Sunscan Canopy Analysis System for P.A.R measurements



Shoot lenght and Plant leaf area by Epson V700 scan and Winfolia image processing

Table 1. Chemical-Bromatological composition (%)											
	CP			NDF			ADF			ADL	
	PS	FS		PS	FS		PS	FS		PS	FS
L100MIX	18 ^c	12 ^{bc}	**	42 ^a	37 ^a	*	29 [°]	28 ^a	NS	11 ^c	6 ^a
L80GMIX	15 ^b	9 ^{ab}	**	47 ^b	45 ^b	NS	33 ^b	28 ^a	***	5 ^{ab}	4 ^a
100BCLO	18 ^{bc}	14 ^c	*	41 ^a	40 ^a	NS	29 ^a	29 ^a	NS	10 ^{bc}	6 ^a
L60SNPA	9 ^a	9 ^a	NS	52 ^c	54 ^c	NS	30 ^a	34 ^b	**	4 ^a	4 ^a

RESULTS

- Light interception by cork trees was 85%, 77% and 70% in January, April and May respectively;
- CP content significantly increased (up to 57%) in partial shade, whereas NDF was not significantly affected by light intensity (Table 1);
- Beneath cork oak cover with a partial shade (70%), aboveground dry matter yield represent an average of about 50% compared values under full sunlight of legume based swards (Table 2);
- The rates on N derived from the atmosphere by the understory legumes, estimated by ¹⁵N isotopic dilution method and using barley are a non-fixing reference species, were about half than the corresponding values obtained under full sunlight (Table 3);
- Partial shade led to longer shoots and wider leaf plant area. Moreover, different light intensity did not affected the chlorophyll content of legume species, on the contrary, chlorophyll fluorescence was significantly affected (Table 4).

Table 3. N content and yield, atom% ¹⁵ N excess, Ndfa percentage and fixed N.													
	N (%)		N yield (kg ha ⁻¹)		Atom % ¹⁵ N excess			Ndfa (%)		Fixed N (kg ha ⁻¹)			
	PS	FS	PS	FS		PS	FS		PS	FS		PS	FS
L100MIX	3.2 ^b	2.5 ^{ab}	40 ^b	54 ^b	NS	0.042 ^a	0.024 ^a	**	67 ^a	77 ^a	*	26 ^{ab}	42 ^b
L80GMIX	3.2 ^b	2.5 ^{ab}	43 ^b	78 ^b	**	0.047 ^a	0.016 ^a	***	62 ^a	85 ^a	***	26 ^{ab}	66 ^c
100BCLO	3.1 ^b	2.1 ^a	**	45 ^b	66 ^b	NS	0.037 ^a	0.015 ^a	**	70 ^a	86 ^a	**	31 ^b
L60SNPA	2.4 ^a	2.6 ^b	NS	10 ^a	14 ^a	NS	0.019 ^a	0.018 ^a	NS	84 ^b	82 ^a	NS	8 ^a

Table 2. Dry Matter Yield (Mg ha ⁻¹)			
	PS	FS	
L100MIX	1.6 ^a	2.9 [°]	*
L80GMIX	1.9 ^a	4.3 ^b	***
100BCLO	1.7 ^a	3.6 ^{ab}	**
L60SNPA	1.3 ^a	3.2 ^{ab}	**
average	1.6	3.5	

Table 4. Chlorophyll contents (SPAD units), Chlorophyll fluorescence (Fv/Fm), Shoot lenght and Plant leaf area												
	Chl content SPAD units			Chl fluorence Fv/Fm			Shoot lenght (cm)			Plant leaf area (cm ²)		
	PS	FS		PS	FS		PS	FS		PS	FS	
L100MIX												
• <i>O. sativus</i>	26 ^a	27 ^a	NS	0.827 ^{efg}	0.596 ^f	***	53	43	NS	9.3	4.4	***
• <i>T. resupinatum</i>	39 ^b	37 ^{abc}	NS	0.815 ^{de}	0.328 ^c	***	50	33	*	4.9	2.0	***
• <i>T. subterraneum</i>	42 ^{bcd}	40 ^{bc}	NS	0.822 ^e	0.365 ^d	***	38	50	*	5.9	3.3	**
• <i>T. vesiculosum</i>	44 ^{de}	47 ^{cd}	NS	0.691 ^b	0.151 ^a	***	48	49	NS	11.1	8.5	**
• <i>T. michelianum</i>	48 ^{ef}	55 ^d	NS	0.838 ^g	0.642 ^g	***	58	32	***	5.0	3.2	*
• <i>T. incarnatum</i>	50 ^f	43 ^{bc}	NS	0.806 ^d	0.273 ^b	***	48	34	*	12.3	6.9	***
L80GMIX												
• <i>T. subterraneum</i>	40 ^{bc}	38 ^{abc}	NS	0.666 ^a	0.600 ^f	***	28	35	NS	5.5	2.9	**
• <i>L. rigidum</i>	41 ^{bcd}	38 ^{abc}	NS	0.735 ^c	0.214 ^a	***	-	-	-	-	-	-
• <i>M. polymorpha</i>	44 ^{cde}	39 ^{abc}	NS	0.836 ^{fg}	0.200 ^a	***	69	39	***	5.1	2.5	**
100BCLO												
<i>T. spumosum</i>	40.8 ^{bcd}	37 ^{abc}	NS	0.824 ^{ef}	0.466 ^e	***	12	17	NS	5.0	1.4	**

References: Unkovich M.J. 2010. Plant Soil 329:75-89

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