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The Seed Bank Dynamics as a Tool for Evaluating the Pasture Improvement Efficiency in a Mediterranean Environment

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Introduction

The ecology of seed bank is very informative of the vegetation development and persistence (Leck *et al.*, 1989) and of the conservation of plant communities and species, mainly depending on the incidence of the persistent fraction of the seed bank (Diemont, 1990). The composition of the herbaceous community, and its soil seed bank, in the Mediterranean rangelands is highly influenced by pasture management, climatic and topographic conditions, productivity levels (Osem *et al.*, 2002). In this paper, with the aim of evaluating the efficiency of a legume-based over-sown pasture in Central Sardinia, the seed bank dynamic was observed during three years.

Methodology

The trial was carried out during 1997-2000 at Usellus (Western Sardinia, Italy). The soil is clay-sandy sub-acid, with low N and P_2O_5 content, and the climate is Mediterranean semi-arid with average annual rainfall of 610 mm. In October 1997, 4.8 ha of low-quality pasture was oversown with an annual legumes mixture (subclover 'Trikkala' and 'Clare' and burr medic 'Anglona') and fertilised with 80 kg ha^{-1} of P_2O_5 and 20 kg ha^{-1} of N. The germinable seed bank (GSB) was assessed in 100 intact soil cores (8 cm Ø x 4 cm depth) and separated in the following fractions (Perez *et al.*, 1998): a) RG (germination in watered field conditions); b) HT (21 days of test duration, 8/16 h of darkness/light and 20/30°C of T° daily cycle); c) LT (21 days of test duration, 3 - 5°C constantly); d) GA (application of 600 mg/kg of gibberellic acid, 35 days of test duration, 8/16 h of darkness/light and 15/35°C of T° daily cycle). GSB was obtained by summing RG+HT+LT+GA. The transient seed bank (TSB) was calculated by summing RG, HT and LT fractions. GA was considered as a contribution of the GSB to the persistent seed bank. The composition of the overlaying vegetation was estimated using an HFRO sward stick, by recording 4 leaf contacts at the vertices of 1200 random quadrats (20 x 20 cm).

Results

In the improved pasture, GSB increased respectively of 46%, 174% and 36% in each of the three years (table 1). This increase was mainly due to the high contribution of spontaneous grasses to the TSB, particularly in the 2^{nd} year. A good establishment of the introduced legumes was observed in the 1^{st} year, when the 22% of GSB was represented by subclover and burr medic seeds, *vs.* less than 10% in the unimproved test. A reduction of the introduced legumes occurred in the last two years, as spontaneous grasses seeds increased. Despite of the decline of its presence in GSB after the first self-reseeding, burr medic showed a high and quite constant contribution to GA, with 29, 25 and 21% , respectively in the three years. In the improved pasture, only burr medic maintained a constant pattern of germination throughout the years. Summer occasional rains in the 2^{nd} and 3^{rd} year caused an early germination of subclover (*false break*), causing its reduction within the TSB. The spontaneous grasses dominated the TSB, mainly in the last two years, as a response both to the higher soil N content and to the better rainfall regimes. The TSB corresponded quite well to the overlaying vegetation composition (table 2) observed two months later in the field (November), indicating that this fraction is a good estimate of the actual vegetation.

Table 1 – Number of germinated seeds (on 100 samples) and percentage of pasture species belonging to different seed bank fractions in the 3-years trial. Values in italics are referred to the unimproved pasture.

Year	Treatment	Germinated seeds		Grasses		Subclover		Burr medic		Other legumes		Other species	
1997-98	RG	4206	*2203*	49	*48*	17	*10*	6	*1*	5	*3*	23	*38*
	HT	478	*397*	23	*25*	2	*2*	-	-	18	*9*	56	*64*
	LT	69	*43*	23	-	11	-	8	-	25	*54*	33	*46*
	GA	322	*107*	5	*13*	12	*6*	29	*16*	17	*47*	37	*19*
GSB composition (%)				43	*43*	15	*8*	7	*1*	8	*7*	27	*41*
1998-99	RG	9083	*3150*	79	*66*	3	*1*	2	-	7	*14*	9	*18*
	HT	437	*245*	43	*41*	1	-	-	-	11	-	44	*57*
	LT	368	*170*	49	*35*	3	-	4	*3*	4	*6*	41	*56*
	GA	583	*250*	6	*4*	10	*8*	25	*12*	10	*20*	48	*54*
GSB composition (%)				73	*59*	3	*1*	3	*1*	7	*13*	14	*25*
1999-00	RG	6634	*3391*	73	*74*	4	-	4	*3*	7	*4*	11	*19*
	HT	714	*1263*	17	*24*	2	-	1	-	1	-	82	*72*
	LT	182	*181*	28	*38*	3	-	5	*3*	13	-	51	*59*
	GA	411	*188*	8	*13*	4	-	21	-	10	*10*	58	*77*
GSB composition (%)				64	*60*	4	*0*	5	*2*	7	*3*	21	*34*
Source of variation													
Year				***	*	***	*	n.s.	n.s.	***	***	***	n.s.
Treatment				***	***	***	*	***	**	***	**	***	***
Year*treatment				***	*	**	**	n.s.	*	***	***	***	***

n.s. = not significant; * = significant for $P \leq 0.05$; ** = significant for $P \leq 0.01$; *** = significant for $P \leq 0.001$.

Table 2 – Floristic composition of the transient seed bank (TSB), gibberellic acid fraction (GA) and overlaying vegetation in autumn.

Component	TSB (%)	GA (%)	Vegetation (%)
Grasses	42	5	48
Subclover	15	12	22
Burr medic	5	29	5
Other legumes	7	17	3
Other species	25	40	22

Conclusions

The analysis of the transient and persistent seed bank short-term dynamics confirmed to be worth to forecast the efficiency of the pasture improvement (Cocks, 1992). This methodology shows reliability in estimating TSB for predicting the composition of the potential overlaying vegetation.

In terms of contribution to the persistent seed bank, the results confirm the highly conservative role of the hardseeded legumes and dormant seeds, in buffering against the quick changes in the species composition (Fenner, 1985, Pake and Venables, 1996).

An early determination of the GSB composition could be useful for an efficient pasture management aimed at exploiting the capability of some legumes to contribute to the persistent seed bank and improve the pasture quality and soil fertility.

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