Hard seed breakdown pattern of sulla (Hedysarum coronarium L.) in relation to its regeneration capacity and persistence

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Hard seed breakdown pattern of sulla (*Hedysarum coronarium* L.) in relation to its regeneration capacity and persistence

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SUMMARY - Sulla (*Hedysarum coronarium* L.) is a perennial legume characterized by a low persistence. In the year after sowing a double autumn regeneration mechanism can occur when seed has been set. In fact it regrows from previous year plants but also regenerates new seedlings from seed, like annual self-reseeding legumes. This research, carried out in Sardinia (Italy), was aimed to study and understand the hard seed breakdown pattern of sulla in relation to its regeneration and persistence. The first results of the year 1994-95 are reported in this paper.

Key words: *Hedysarum coronarium* L., regrowth, hard seeds, re-establishment, persistence.

RESUME *- "Modèle de réduction de la dureté des graines de sainfoin (*Hedysarum coronarium *L.) en relation avec sa capacité de régénération et sa persistance". Le sainfoin d'Espagne (*Hedysarum coronarium *L.) est une légumineuse vivace qui se caractérise par sa persistance réduite. L'année après la semée le sainfoin peut régénérer soit par rejet des plantes vieilles, soit par implantation de nouvelles plantes qui naissent des graines dures comment il s'avère pour les légumineuses annuelles capables de réensemencer, les années ou de la graine est produite à l'avance. Cette recherche menée en Sardaigne (Italie), a été portée sur l'étude et la intelligence du mécanisme par le quel la dureté des graines du sainfoin est réduite en relation avec sa régénération et sa persistance. Dans ce travail les premiers résultats de l'année 1994-95 sont reportées.*

Mots-clés *:* Hedysarum coronarium *L., rejet, graines dures, réimplantation, persistance.*

Introduction

Sulla (*Hedysarum coronarium* L.) is a short lived perennial legume well adapted to the semi-arid Mediterranean environments on clay and calcareous soils. It is used for hay, silage and as pasture plant (Pinto *et al.*, 1994; Sulas *et al.*, 1995) and also for non-forage purposes (Watson, 1982). Being typically a biennial species it is characterized by a very low plant survival after the second year of the cycle. Regarding the autumn regeneration in the year after sowing, sulla usually regrows from previous year plants, like a perennial species, but also it re-establishes from new seedlings originating by seeds produced in the previous spring or before, like an annual self-reseeding legume. The persistence of annual legumes depends on the survival of seed through one or more growing season as hard seed, particularly in environments characterized by unpredictable amount and distribution of rainfall. Hardseededness (seed coat impermeability), due to both environmental and genetic factors, is of great ecological significance for the legume persistence (Taylor and Ewing, 1988). According to Muslera Pardo and Ratera Garcia (1984) when sulla plant has not produced seed due to hay cutting or a severe grazing, autumn regeneration will be from regrowth but also from new seedlings, if seeds had been set before. When the plant has produced seed, the mobilization of reserves toward the fruits can cause weakening and death of roots, reducing regrowth; moreover a low seed regeneration can be determined by the high amount of the previous spring hard seeds, if there is a lack of seed produced before and more soft.

Taking into account the relationship between regrowth from plants and new seedlings this research was aimed to study and understand the hardseededness and the hard seed breakdown pattern of *H.*

coronarium in relation to its regeneration capacity and persistence. The first year results are reported in this paper.

Materials and methods

The experiment was carried out in north Sardinia (Italy) on flat clay-loam calcareous soil, pH 7.5 with low N and P_2O_5 content and adequate K_2O content, during 1994-95 year. The climate of the area is semi-arid Mediterranean, with a mild winter and an average annual rainfall of 547 mm. The Italian commercial varieties 'Grimaldi' and 'Sparacia' were compared in a completely randomized block design with three replicates. Plots (18 m^2 in size each) were established in late November at a sowing rate of 30 kg ha^{-1} of naked seed inoculated with a Sardinian strain of *Rhizobium hedisari*. Fertilization was applied with 100 kg ha^{-1} $year^{-1}$ of P_2O_5. The following data were collected: seedling establishment (no. m^{-2}); DM yield, its botanical composition and partitioning in stems, leaves and racemes on plot subsample; flowering time, seed yield and its components and hardseededness from uncut plots. When the loments were completely mature (July), samples were randomly taken from the uncut plants every 20 days, for six sampling times. After loments started to fall (end of August) further samples were collected from the soil. Loment of two subsamples were threshed by hand to obtain naked seed, avoiding any scarification. Both loments (i.e. articles) and naked seed were put on sterile Petri dishes to germinate at 20°C for 14 days on moistened filter paper.

Moreover the survival of sulla plants (no. m^{-2}) respectively of hay cut and uncut plots, since emergence to the year after sowing, was monitored on sampling areas.

Results and discussion

The total annual rainfall from September to August was 488 mm with absence of rain in January and February, while rain occurred in spring; only 246 mm of rain fallen from the sowing date to the cutting. This unfavourable weather markedly affected the crop development and the total yield. In summer the diurnal air fluctuation was on average 10°C and the *maximum* daily air temperature was recorded in August (35.3°C). In September 1995 rain was 74 mm.

About 200 seedlings m^{-2} were recorded in 'Grimaldi' and 'Sparacia', but seedling establishment and development were delayed. Only one cutting in early June was made for both varieties. Total forage yield of 'Sparacia' (Table 1) was very low with a negligible content of stem and racemes compared to 'Grimaldi' that, on the contrary, better exploited late spring rain both for forage and seed production. The lack of seed production and the lower forage yield in 'Sparacia' compared to 'Grimaldi' can be explained by the different earliness and origin of these varieties.

Table 1. Total dry matter yield (TDMY) in t ha^{-1}, sulla contribution (SC) and partitioning of sulla phytomass in % DM (year 1994-95)

		% Phytomass partitioning			
	TDMY	SC	Stems	Leaves	Racemes
'Sparacia'	0.84	56	1	100	1
'Grimaldi'	2.97	62	21	58	21

Flowering of 'Grimaldi' started in May, about 160 days after the emergence, and the loments were completely ripened in middle July. Actual seed yield was low (Table 2), only 150 kg ha^{-1}, but it was satisfactory compared to 'Sparacia' (not valuable) and taking into account the weather trend. The low number of racemes per stem mainly affected the seed yield.

The hard seed breakdown pattern of loments and naked seeds during the summer is reported in Figure 1. The initial hard seed content was about 95% at the end of July and it decreased to 74 and 80%

respectively in naked seeds and loments in early October. Hardseededness of loments collected from the soil (data not shown) was 64% at the end of September when, due to the abundant rain, loments started to germinate in field. Similar pattern but lower percentage of hard seed were constantly observed in naked seed than in loments, probably due to its protection effect against water, as found by Stringi *et al.* (1980) in sulla germination trials. The hard seed breakdown results were also similar to those obtained by Olea and Verdasco (1985) for sulla in laboratory, under simulated temperatures of south west Spain.

Table 2. Actual seed yield and its components in sulla 'Grimaldi' (year 1994-95)

		Average	SE
Stems m^{-2}	(no.)	131.3	5.7
Racemes per stem	(no.)	1.1	0.1
Loments per stem	(no.)	11.2	0.9
Articles per loment	(no.)	3.0	0.2
Seeds per article	(no.)	0.6	0.1
1000 seed weight	g	5.1	0.0
Actual seed yield	Kg ha^{-1}	156.3	44.6

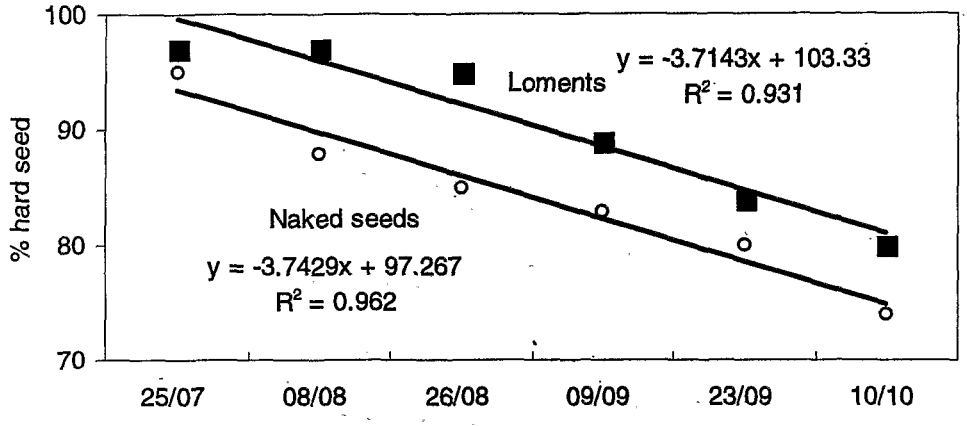

Figure 1. Hard seed breakdown pattern of sulla 'Grimaldi' from July to October 1995.

From the initial number of seedlings after emergence, a relevant reduction of 55-60 sulla plants m^2 was recorded at the cutting time, it was probably due to the effect of dry periods and for the competition inter plants. After cutting,about 20 plants m^{-2} died during summer, while the number of non surviving plants was neglegible in uncut plots. A reduction of the plant number after cutting has been also found by other authors. According to D. Gianbalvo (pers. comm.) a decrement of 40-50% of the sulla plants is common from the first to the second year crop in Sicily.

Taking into account the hardseededness of the loments in the soil at the end of summer, a seed production of only 12.5 kg ha^{-1} can regenerate a sufficient number of new plants to replace the dead ones during the year. In Central Italy, even if utilized up to spring sulla produce seed and it can be exploited for both forage and seed production in the same year as reported by Roggero *et al.* (1996).

Conclusion

The results confirm that sulla has a hard seeds break down pattern similar to that of annual self-reseeding legumes; the content of hard seed resulted higher than that of subterranean clover but lower compared to annual medics.

Nevertheless a relevant amount of the loments after complete maturation, remain on the plant during the whole summer. The softening of the seeds on the soil appears higher. This aspect and others like the effect of the loment burial by grazing or tillage and the hard seed breakdown pattern of the same varieties in different environments need more investigation.

Sulla has a self-reseeding capacity that can be exploited to improve its scarce persistence by new seedlings compensating the dead plants. The choice of an appropriate management aimed at assuring a *minimum* seed set in the year after sowing can be an important and cheap tool in order to prolong the short duration of the meadow.

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