Growing cycle of Hedysarum coronarium L. (sulla): relationship between plant density, stem length, forage yield and phytomass partitioning

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Growing cycle of *Hedysarum coronarium* L. (sulla): relationship between plant density, stem length, forage yield and phytomass partitioning

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Summary - Sulla (*Hedysarum coronarium* L.) is a biennal Mediterranean legume and its forage production is typically concentrated in the year after sowing. The main objective of this research was to evaluate the plant dynamic, height, forage production and phytomass partitioning under undisturbate herbage accumulation of the sulla grown at agronomic plant density. When compared to the second year, the first year crop of sulla was characterised by a shorter growing season, lower dry matter per plant, stem length, stem contribution to the total dry matter yield. Plant density and contributions of leaflets, petioles and racemes were higher. Results have evidenced substantial and contrasting differences in sulla meadow structure and productivity, during each year of the *biennium* cycle, to be taken into account for an appropriate management of the sulla meadow.

Key-words: *Hedysarum coronarium* L., crop cycle, plant density, DM yield, phytomass partitioning

Résumé- *Le sulla (*Hedysarum coronarium *L.) est une légumineuse méditerranéenne bisannuelle dont la production fourragère est concentrée sur l'année suivant le semis. Un essai réalisé sur l'ensemble du cycle bisannuel pour une plantation à densité agronomique, a évalué la dynamique des plantes, leur hauteur et leur production fourragère sans perturbation. La première saison présente une période de croissance plus courte, une productivité, une longueur de tige et un rapport tige/feuille inférieurs mais une densité de plantes et une contribution des feuilles et rameaux supérieures. Les différence observées dans la structure et la productivité de la culture sont discutées pour une meilleure gestion des prairies de sulla.*

Mots-clés: Hedysarum coronarium *L., cycle de vie, densité, phytomasse, rapports structuraux*

Introduction

Sulla (*Hedysarum coronarium* L.) is a legume well adapted to semi-arid Mediterranean environments and is used for hay, silage and pasture; moreover, it is an interesting example of a multiple-use species (Bullitta and Sulas, 1998).

Growing cycle

Sulla is a short duration perennial species (biennial or triennal); under Mediterranean conditions it is usually sowed in autumn, that represents the beginning of the first year crop (1^{st}YC), and its seedling development is affected by sowing and first rains time. During winter it is able to grow in presence of favourable temperatures; in spring the growth rates increase very quickly, reaching the maximum from the end of March (south Italy and Isles) at flowering and stem lignification time. In summer, sulla exhibits a dormancy, based on high temperature and photoperiod; for these reasons, the summer irrigation is ineffective and its growing season cannot be prolonged by water supply. After late summer rains, sulla plants start to regrow (vegetative regeneration) and begin the second year cycle (2^{nd}YC). From the end of the first to the second year, a reduction in plant density has usually observed (Gianbalvo, pers. comm.) while only a few plants are still viable in the third year;

consequently, sulla meadow is re-sowed every two years. Moreover, autumn regeneration can also occur via seed from the soil seed bank.

Sulla forage production is typically concentrated in the year after sowing, mainly in local ecotypes (Stringi and Amato, 1998) and it is important to better understand which changes of plant component are associated to this production pattern.

Within a biennial cycle of the sulla crop, grown at agronomic plant density, the main objective of this research was to evaluate the plant dynamic, stem length, forage production and phytomass partitioning under undisturbated herbage accumulation.

Materials and methods

The experiment was carried out during 1996-98 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. The climate of the area is semi-arid Mediterranean, with a mild winter and an average annual rainfall of 547 mm. The Italian commercial variety of sulla 'Grimaldi' was established on 17th October at a sowing rate of 25 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. Plots were allotted in a completely randomised block design with three replicates. The following data were collected: seedling establishment (no. m^{-2}), plant dynamic during the *biennium*, stem length, DM yield and phytomass partitioning in stems, leaflets, petioles and racemes. From the collected data, the characteristics and evolution of sulla plant in each year of the cycle were compared.

Results and discussion

The total annual rainfall from September to August was 450 and 429 mm respectively in the year 1996-97 and 1997-98, of which 314 mm of rain fallen from the sowing date to the last cutting period (222 days) and 421 mm from the start of regrowth to the final cutting (259 days). Emergence was regular and about 250 seedlings m^{-2} were recorded one month after sowing.

DM production

The DM yields of the sulla were influenced by both environmental conditions and year of cycle. Favourable mild temperatures were experienced during winter 1998, allowing a remarkable DM availability with a negligible presence of weeds. In relative terms, 62% of the total DM yield in the *biennium* cycle was produced in the 2ndYC (table 1) when the surviving plants represented about one third of those recorded at the emergence.

Table 1 - Evolution of average plant density (no. m^{-2}) and available DM (t ha^{-1}) during the biennial cycle of sulla.

1st YC				2nd YC		
Establishment		End winter	Late spring	Winter	End winter	Late spring
Plant	250	220	120	100	80	80
DM	-	3.9	9.2	4.3	10.0	15.0

The progressive reduction in plant density markedly influenced the DM yield per plant (figure 1a). The lower values and a reduced variability between plants were observed in 1stYC, presumably due to the higher competition between plants in relation to their initial density. In 2ndYC, the reduced density and the more prolonged growing season allowed highest DM plant with a relevant variability between plants.

A similar pattern was observed about the relationship between stem length and plant density (figure 1b), as a consequence of the close influence of the stem length on the plant DM (data not shown).

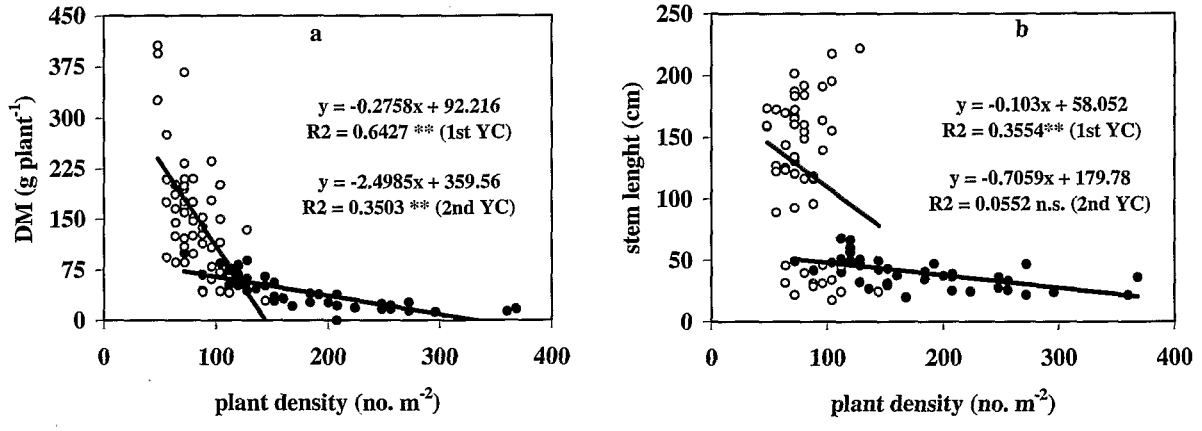

Figure 1 - Relationship between plant DM and density (a) and between stem length and plant density (b); 1stYC = bold circles; 2ndYC = empty circles; ** = significant at $P < 0.01$; n.s. = not significant.

Phytomass partitioning

Shorter stems were associated to the highest leaflet and petiole contributions (figure 2a and b) to the total above ground phytomass in 1stYC; as a consequence, a better forage quality than that of 2ndYC is expected.

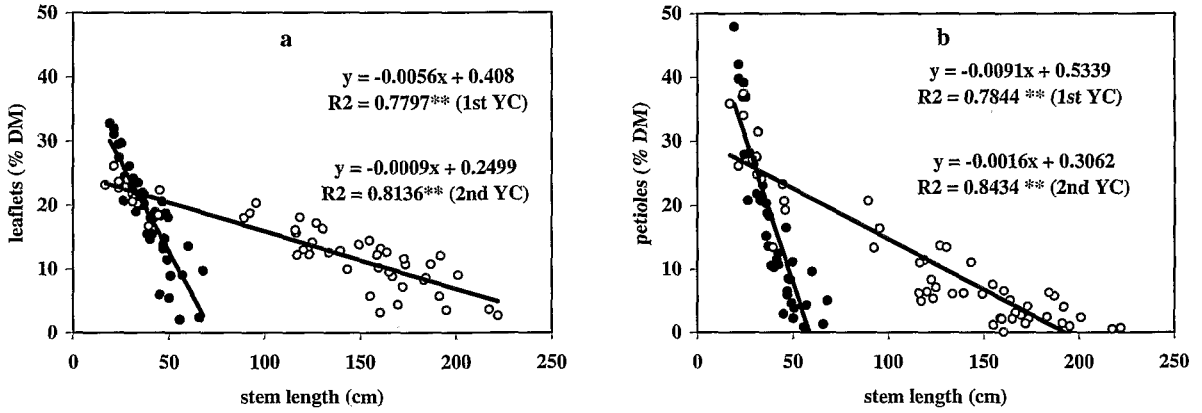

Figure 2 - Relationship between stem length and DM contribution of leaflets (a) and petioles (b); 1stYC = bold circles; 2ndYC = empty circles; ** = significant at $P < 0.01$.

In both 1stYC and 2ndYC, stem elongation was followed by an increased stem contribution to the total above ground biomass; in 2ndYC (figure 3a) it was more relevant and around twice higher than in the 1stYC. About racemes, its highest contribution was reached in 1stYC plants (figure 3, b) whose the remaining component DM was lower in relative and absolute terms.

The high yield obtained under undisturbate herbage accumulation have confirmed the great potential forage production of sulla, in spite of lower values recorded under repeated utilisation (Stringi *et al.*, 1991). When compared to the 2ndYC, the 1stYC was characterised by a

shorter growing season, lower DM per plant, stem length, stem contribution and a higher plant density, leaflet, petiole and raceme contributions. Consequently, sulla plant showed a contrasting vegetation structure during each year of crop cycle, being a peculiar characteristic of this species. Moreover, the evolution of plant components may be of major importance in the quality of forage produced (Pinto *et al.*, 1993).

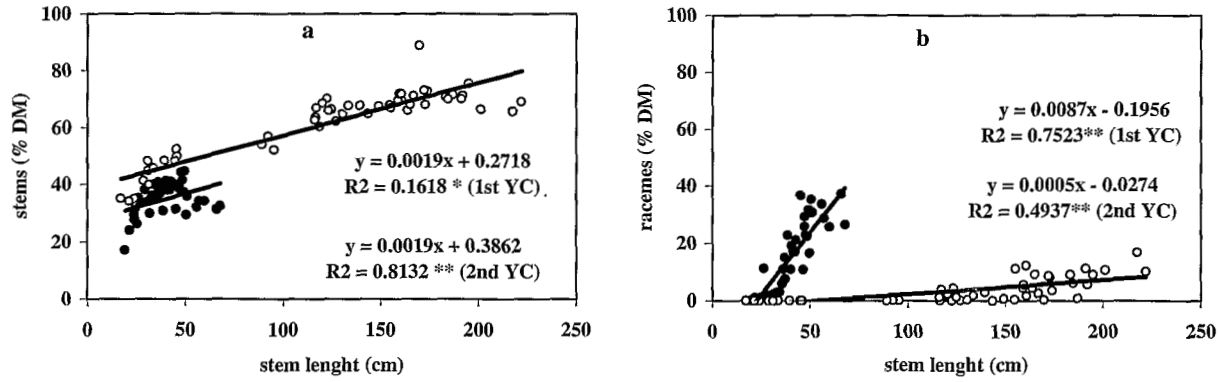

Figure 3 - Relationship between stem length and DM contribution of stems (a) and racemes (b). 1stYC = bold circles; 2ndYC = empty circles; * = significant at $P < 0.05$; ** = significant at $P < 0.01$.

Some typical characteristics observed under undisturbated condition, can be modified by the farm management, in relation to the feeding system; for example, stem DM contribution in the 2ndYC can be reduced by increasing the number of utilisations with a positive effects on the forage quality but, always, causing a reduction of total yield (Sulas *et al.*, 1997).

Conclusions

The research carried out at plant level and on agronomic density have revealed substantial and contrasting differences in sulla meadow structure and productivity, during each year of the *biennium* cycle. These results represent a key point to set up an appropriated management schemes and, due to the difference between 1st and 2ndYC, their contextual presence at the farm is suggested, in order to better exploit the forage potential and different type of utilisation (hay, early grazing and silage) of this legume.

References

Bullitta, P., Sulas, L. (1998). Le possibilità di utilizzazione della sulla con il pascolamento e il suo inserimento nei sistemi pascolivi sardi. *I Georgofili, Quaderni 1998*, 1, Firenze: 53-71.

Pinto, P.A., Barradas, G.J., Tenreiro, P.C. (1993). Growth analisys and chemical composition of sulla (*Hedysarum coronarium* L.). *Proceeding of 17th IGC*. Palmerston North, New Zealand 8-12-February 1993: 587-589.

Stringi, L., Amato, G. (1998). La sulla nell'ambiente siciliano: utilizzazione e prospettive di valorizzazione. *I Georgofili, Quaderni 1998, 1*, Firenze: 29-52.

Stringi, L., Amato, G., Leto, G., Alicata, M.L., Gristina, L., Di Prima, G. (1991). Produttività, composizione chimica e valore nutritivo della sulla (*Hedysarum coronarium* L.) sottoposta a pascolo in ambiente semiarido. *Riv. di Agron.*, 2, 184-194.

Sulas, L., Re, G.A., Ledda, L., Caredda, S. (1997). The effect of utilization frequency on the forage production of sulla (*Hedysarum coronarium* L.). *Italian Journal of Agronomy*, 2, 89-94.