Dynamics of shoot and root growth and adaptation to the environment of sainfoin (Onobrychis viciaefolia Scop.) in a hilly area of southern Italy

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Dynamics of shoot and root growth and adaptation to the environment of sainfoin (*Onobrychis viciaefolia* Scop.) in a hilly area of southern Italy

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Summary - Relation between aboveground and belowground growth of perennial forage crops are affected by ontogenesis and the environment in a more complex way than in other annual herbaceous crops. The purpose of this research is to evaluate the biological behaviour and adaptation to the environment of two sainfoin cultivars (ecotype "Firenzuola" and variety "Fakir") in a hilly area of southern Italy. At five phenological stages of the biological cycle, stem length, leaf area index and dry matter of stems, leaves, racemes, seeds, and taproot, were determined. At the end of cycle, the maximum diameter of taproot was measured. The allometric relations of the two cultivars exhibited a different behaviour. Cultivar Fakir showed, at seed ripeness, an increase of taproot mass. This could increase the amount of metabolic energy available for regrowth and ultimately affect its persistence.

Key-words: *Onobrychis viciaefolia* Scop., biological cycle, shoot, taproot

Résumé - *Les relations entre la partie aérienne et les racines des cultures foraggères sont influencé par l'ontogénèse et par les conditions climatiques in une manière plus compliquée que les plantes annuelles parce que'elles sont des plantes pérennees. L'objectif de cet expérimentation est d'observer la dynamique de croissace et l'adaptation de deux cultivars de sainfoin (l'écotype "Firenzuola" et la variété "Fakir") au climat de la colline du sud de l'Italie. Les composantes de la biomass ont été determinées à different stades phénologiques. La variété Fakir montre, à la maturité de la semence, une croissance des pivots racinaires. Cela peut augmenter la pérénnité de la culture.*

Mots-clés: Onobrychis viciaefolia *Scop., cycle biologique, parties aériennes, pivots racinaires*

Introduction

The optimum growth of plants depends on the maintenance of an efficient balance of functions between roots and shoots, such that neither suffers serious deficiencies in supplies of essential substances contributed by the other. In order for perennial legumes to resist environmental stress, enzymatic mobilization of taproot carbohydrates is considered essential (Kallenbach *et al.,* 1995). The taproot of perennial legumes stores metabolites needed to withstand environmental stress or provide substrate for regrowth. However, root-shoot ratios vary widely among species, with age, and with environmental conditions. The vegetative growth of sainfoin is unaltered by daylength (Kallenbach *et al.,* 1995); conversely increasing air or soil temperature by 20°C decreased crown, taproot, and fine root mass by as much as 98% (Kallenbach *et al.*, 1996). The pourpose of this work was to characterise the allometric relations on sainfoin (Onobrychis viciaefolia) comparing two cultivars.

Materials and methods

The research was conducted in 1995-96 in a hilly area of Southern Italy in Basilicata region (Guardia Perticara-Pz), at 700 m o.s.l. on a deep loamy-clay soil, with subalkaline reaction and a satisfactory amount of nitrogen (0.115%) and exchangeable potassium (345 ppm), but with a low quantity of phosphorus (58 ppm).

Two cultivars of sainfoin (ecotypes "Firenzuola" and variety "Fakir") were sown in March 1995 on a plot of 3000 m^2. The soil had been previously ploughed to 40 cm, and fertilised with 100 units of P_2O_5. The distance between rows was 20 cm. Harvest was not undertaken during the establishment year (1995). Growth analysis was conducted beginning from the autumn of 1995 (november/10) until the seed ripening in the summer of 1996 (july/4) measuring LAI, plant height, aboveground dry matter for each organ and taproot dry matter at the most important phenological stages of the biological cycle. At seed ripeness the maximum diameter of taproot and chemical composition of seed were measured. Each sample was collected from two neighbouring row segments of 30 cm and replicated 3 times.

The total rainfall from October to September was 768 mm, mostly concentrated in autumn (241 mm) and winter (314 mm), while it was rather scarce in the spring period (121 mm) and summer period (90 mm). Freezing temperatures were recorded in the last decade of February (absolute minimum –5.7 °C) and first decade of March (absolute minimum –5.2°C). Maximum temperature were above 30° C in July (absolute maximum 35° C).

Results and discussion

Total dry matter (aboveground + belowgrond) peaked at flowering for both cultivars (fig. 1). The two cultivars flowered at different times. Flowering date was may/20 for the Firenzuola and june/4 for the Fakir.

The high value of total dry matter measured in january was due to the favourable temperatures trend from the end of november until the end of january (maximum in average 10.5°C and minimum in average 6.0°C). During the winter period high values of aboveground dry matter of *Hedysarum coronarium* L. were measured in a study of growth analysis that was conducted in the same environment (De Falco *et al.*, 1996).

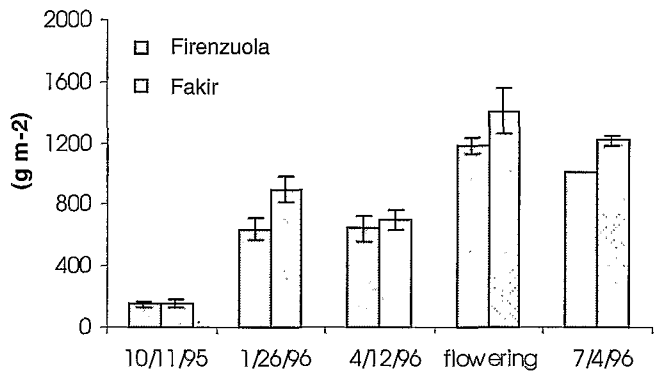

Fig. 1 – Time course of total dry matter (aboveground+beloweground). Vertical bars represents standard deviation of the mean

The cultivar Fakir showed a reduction in the accumulation of dry matter corresponding to the lower temperatures during the last decade of February and first decade of March. This effect was more evident on leaves as shown by LAI values (fig. 2a).

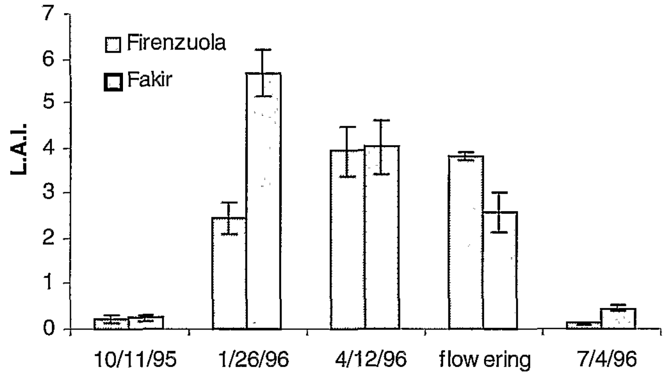

Fig. 2a – Time course of total L.A.I.. Vertical bars represents standard deviation of the mean

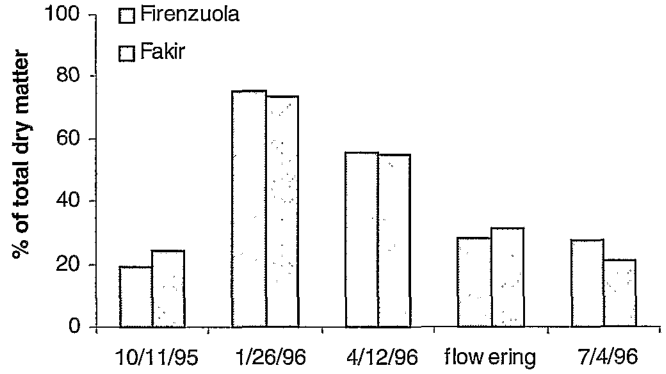

Fig. 2b – Time course of leaves percentage of total dry matter

In winter, leaf contribution to total dry matter showed higher values (75%) (fig. 2b); conversely stems contribution was lower (fig.3). The latter gave their maximum contribution with a value of 63% for the Firenzuola and 65% for the Fakir respectively at seed ripening and at flowering (fig 3). Plants reached their maximum height at flowering with values of 63.2 cm (±3.3 cm) and 74.7 cm (±5.3 cm) respectively for Firenzuola and Fakir.

In autumn the temperatures were favourable to the allocation of assimilates to the taproot. Starting in autumn and throughout stem elongation there was a significant reduction in partitioning of assimilates to taproots with the percent allocated to taproot falling from 54% for the Firenzuola and 24% for the Fakir to only 4% at the flowering (fig. 4). At seed ripening the contribution of taproots to total dry matter increased to 5% for the Firenzuola and to 17% for the Fakir (fig. 4).

Mowrey and Matches (1991) reported that sainfoin taproot carbohydrates declined to yearly lows during the summer, and increased again in autumn. These authors, though, report that maximum values are found in early spring.

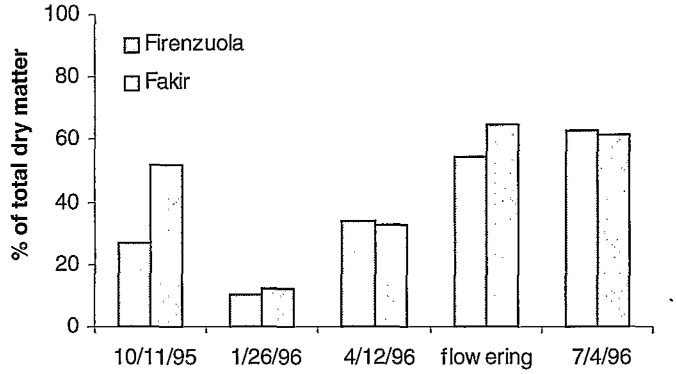

Fig. 3 - Time course of stems percentage of total dry matter

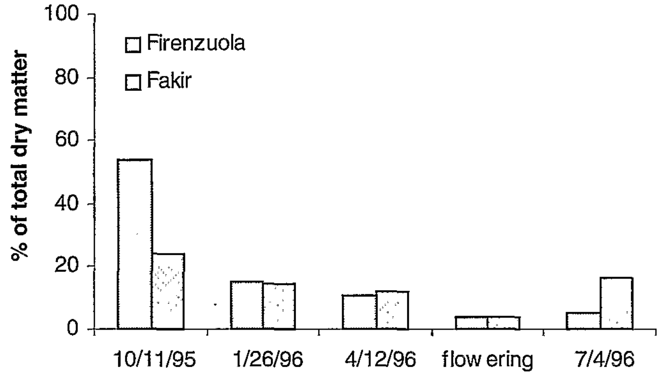

Fig. 4 - Time course of percent of taproot on total dry matter of taproots

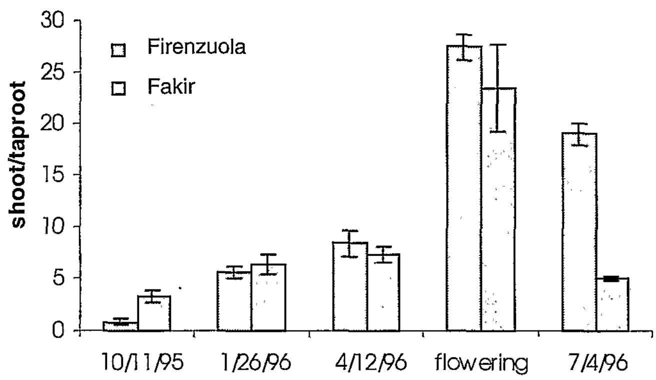

Fig. 5 - Time –course of shoot/taproot ratio. Vertical bars represent standard deviation of the mean

The seed yield was higher for cv Firenzuola (Tab. 1). The chemical composition showed lower protein content and higher fat and fibre content than the values reported from Antongiovanni *et al.*, (1976) for sainfoin seed.

Tab.1. Seed yield and chemical composition of cultivars Firenzuola and Fakir.

	Seed yield ($g\ m^{-2}$)	% protein	% fat	% ashes	% fibre
Fiorenzuola	47.47	12.85	5.93	5.60	17.69
s.d.	*7.03*	*2.05*	*0.41*	*0.07*	*1.61*
Fakir	12.28	11.50	4.50	5.60	17.61
s.d.	*3.78*	*1.41*	*0.58*	*1.02*	*1.95*

Conclusions

In both cultivars total biomass reached a maximum value at flowering.
The behaviour of the two cultivars was different because the growth of Fakir was more concentrated in the top parts compared to Firenzuola in the late fall-early winter period, whereas it showed a higher root mass than Firenzuola at the end of the cycle. This was reflected in the shoot/taproot biomass ratio which was initially higher for cv Fakir than Firenzuola; then it became equal and at the end of the cycle it was much higher for Firenzuola than Fakir.
This probably indicates a higher ability of cultivar Fakir to mobilise photosyntates towards the taproot, since a portions of biomass was shifted to the vegetative structures instead of being accumulated in the seeds (1% and 5% of total dry matter respectively for Firenzuola and Fakir).
Probably the increase of taproot mass of Fakir could increase the amount of metabolic energy available for regrowth and ultimately affects its persistence.

References

Antongiovanni, M., Giorgetti, A., Poli, B.M., Franci, O. (1976). Determinazioni in vitro del valore nutritivo della lupinella (*Onobrychis sativa*) a vari stadi vegetativi. *Zoot.Nutr.Anim.*, 2, 193-204.

De Falco, E., De Franchi, A.S., Landi, G., Pardo, A., Basso, F. (1996). Comportamento biologico ed adattabilità di specie foraggere poliennali in un ambiente collinare meridionale. *Riv. Agr.*, 30, 1, 73-79.

Mowrey, D.P., Matches, A.G. (1991). Persistence of sainfoin under different grazing regimes. *Agron. J.*, 83, 714-716.

Kallenbach, R.L., Matches, A.G., Mahan, J.R. (1995). Daylength influence on the growth and metabolism of sainfoin. *Crop Sci.*, 35, 831-835.

Kallenbach, R.L., Matches, A.G., Mahan, J.R. (1996). Sainfoin regrowth declines as metabolic rate increases with temperature. *Crop Sci.*, 36, 91-97.