SELECTING LUCERNE (MEDICAGO SATIVA COMPLEX) FOR TRAITS CONFERRING ADAPTATION TO GRAZING

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ABSTRACT

A germplasm collection of the *Medicago sativa* complex was evaluated to select genotypes possessing traits possibly conferring adaptation to grazing. Deep-crowned plants, either creeping-rooted or rhizomatous, were found with different frequencies, in all "taxonomic" groups examined. Although belonging to subsp. *sativa*, "mielga" wild populations from Spain were closer to subsp. *falcata* for morpho-physiological traits. Deep-crowned plants could be categorised into four top-growth models, to which corresponded a fairly distinct underground morphology: three were rhizomatous and one creeping-rooted. Cultivars selected for creeping-rootedness did not outyield rhizomatous populations of subsp. x *varia* which, in turn, had better spreading ability. In a subsequent evaluation, clones from selected rhizomatous genotypes had higher yield and better spreading ability than those from selected creeping genotypes. Under the given conditions, expression of creeping-rootedness was always erratic. The results point to the opportunity to pay greater attention to rhizomatous types in breeding grazing-tolerant cultivars.

KEYWORDS

Creeping-root, genetic resources, grazing tolerance, lucerne, *Medicago sativa* complex, rhizomatous habit

INTRODUCTION

The demand of an agriculture extensification and related farming systems characterised by agronomic, economic and environmental sustainability have recently renewed the interest on developing grazing-type lucerne cultivars suited to temperate environments of southern Europe. Grazing tolerance of lucerne is related to the presence of morphological features such as deep-set crown and sideways spreading ability. The latter can be conferred either by the creeping-root character, that is shoot proliferation from horizontal roots, or the rhizomatous habit, *i.e.* radial expansion of the low-set crown by underground stems from which new shoots arise (Heinrichs, 1963). In the past, selection of grazing-type varieties has largely focused on the creeping-root rather than the rhizomatous character. Because of the diversity of climatic environments, farming systems and utilization forms in which lucerne is to be grown, different growth models, both in morphological and physiological terms, are likely to be pursued when selecting grazing-type varieties.

This paper refers on the first phase of a breeding programme focused on germplasm evaluation of the *Medicago sativa* complex, and selection of genotypes possessing traits possibly conferring adaptation to grazing.

EXPERIMENTAL

The investigations were conducted at Lodi, northern Italy (45° 19' N; 9° 30' E; 81 m a.s.l.; 775 mm average annual rainfall) in a sandy-loam soil of good fertility. The trials were carried out under spaced-plant conditions and randomized complete block design with two replications.

Ninety accessions belonging to *M. sativa* subsp. *sativa*, both cultivated types and wild "mielga" populations from Spain; subsp. x *varia*; subsp. *falcata*; and materials from artificial crosses (varieties and breeding stocks) between the above-mentioned taxa were evaluated during three years for traits conferring grazing tolerance, and for top-growth morphology and vigour (see Fig. 1 and Table 1). Artificial crosses included most of the commercial cultivars selected for creeping-rootedness, while subsp. x *varia* and subsp. *falcata* were only represented by natural populations.

A set of 153, deep-crowned plants, categorised within 4 distinct top-growth models (Fig. 1), were selected. They were explanted at the end of the trial to deeply examine the underground morphology. The selected plants were cloned and evaluated in a further 3-year trial with particular reference to dry-matter yield and spreading ability (crown diameter). Statistical comparisons based on analysis of variance were made among taxonomic groups, top-growth models, and individual selected genotypes.

RESULTS AND DISCUSSION

Deep-crowned plants have been found in all the germplasm groups examined, although with different frequency, being about 65% on average in subsp. *falcata*, x *varia* and wild subsp. *sativa* (mielga), 44% in artificial crosses, and 13% only in cultivated subsp. *sativa*. Mielga populations, which are generating some interest in breeding programmes in southern Europe (Prosperi et al., 1990), were closer for most morpho-physiological traits and seasonal growth patterns to subsp. *falcata* than to subsp. *sativa* to which they are attributed on the basis of flower colour and pod coiling. This could represent the results of a convergent adaptation under somewhat similar grazing and climatic (particularly summer drought and winter cold) selective pressures.

Deep-crowned plants proved either rhizomatous or creeping; within the former, 3 different top-growth models were identified, characterised by decreasing basal plant diameter and increasing erectness from D1 to D3 to D4 (Fig. 1). D1 showed lower stem density and slower vegetative recovery at the end of winter (mid-March) compared to any other rhizomatous model (D3 and D4) and to the creeping type (D2).

Although all characterised by a branch-rooted system, the 4 top-growth categories proved rather distinct for underground morphology, so that selection for top-growth characteristics resulted in indirect selection for underground features such as horizontal to vertical root ratio, rhizome density and length, budding activity in late autumn, and deep-set crown diameter (Piano et al., 1996).

D1 types occurred with high frequency (= 35%) in the subsp. *falcata*, subsp. x *varia* and mielga populations; D3 plants were common (20 - 25%) in these 3 groups as well as in artificial crosses; D2 and D4 plants were less common across groups (up to 2.4% and 10%, respectively). The former never appeared in subsp. *sativa* either cultivated or wild, and the latter in subsp. *falcata*.

The creeping cultivars significantly outyielded the rhizomatous wild subsp. *sativa* populations, while they did not differ from the rhizomatous populations of the subsp. x *varia* which, in turn, had the largest basal plant diameter. In the given conditions, creeping-rooted plants were not found in some "creeping" cultivars and attained at most 20% of total in the others at the 3rd year of evaluation. Conversely, in both groups of rhizomatous lucerne, plants with rhizomatous habit were by far the most frequent (> 65%).

In the evaluation of selected genotypes (Table 1), clones originating from D2 creeping plants proved less productive, had lower spreading ability, and slower vegetative recovery at the end of winter than rhizomatous types. The expression of creeping-rootedness at the 3rd year of evaluation was also erratic in these clones, confirming acquired evidence on the complexity of this trait.

The good spreading ability and yield level of rhizomatous materials, particularly those from subsp. x *varia* populations, and the better expressivity of the rhizomatous habit, indicate that breeders should greater attention to this germplasm in the selection of grazing-tolerant cultivars. The variation for plant morpho-physiology existing within rhizomatous types could be exploited to develop cultivars suited to different climatic environments and diversified utilization (multi-purpose systems, soil protecting cover crops, etc.). Studies in progress are investigating the performance of rhizomatous types relative to creeping ones in dense swards, under real grazing and diversified environmental conditions.

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Table 1
Dry-matter yield, basal plant diameter and vegetative recovery at the end of winter (mid-March) in clones from selected plants of lucerne belonging to different morphological models (see Fig. 1)

Model	Dry-matter yield (g/plant)	Basal plant diameter (cm) at the 3rd year	Vegetative recovery (1-5 scale)
D1	209.4 ab	21.1 a	2.0 bc
D2	163.6 b	11.3 c	1.8 c
D3	239.2 a	18.2 ab	2.4 b
D4	257.0 a	16.4 b	3.6 a
Means followed by the same letter are not significantly different at P = 0.05 (Duncan's test)			

Figure 1
Schematic representation of four top-growth models in deep-crowned plants of lucerne. D1, D3 and D4: rhizomatous types; D2: creeping-rooted type.