SELF-RESEEDING FORAGE LEGUMES AS GREEN MANURES IN MEDITERRANEAN CROPPING SYSTEMS

F. Caporali, E. Campiglia and R. Mancinelli
Department of Crop Production, University of Tuscia (Viterbo), Italy (*)

ABSTRACT
Self-regenerating winter annual legumes, like the Subterranean clover and the *Medicago* species, are recognised as typical Mediterranean resources able to contribute to more sustainable cropping systems such as cover crops, living mulches and green manures. Experimental evidence is presented on the capacity of several cultivars of subclover (*Trifolium subterraneum*, L.; *Trifolium yanninicum*, Katzn. & Morley and *Trifolium brachycalycinum*, Katzn. & Morley) and annual *Medicago* species to yield astonishing amounts of aboveground biomass (up to 15 t/ha by the cultivars of *Medicago scutellata*) with high nitrogen content. The total contribution of nitrogen to soil varies (100-300 kg/ha) with the age of the plant, but it is always possible to find cultivars of *Medicago* or *Trifolium* which as green manures are able to meet the nitrogen requirements of both early and late summer crops.

KEYWORDS
self-reseeding legumes; green manures; sustainable cropping systems.

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INTRODUCTION
The use of legume green manure has the potential to reduce the need for synthetic fertilizer as well as herbicide applications in subsequent crops (MacRae and Mehuys, 1985; Dyck *et al*., 1995) and therefore it constitutes a powerful means to confer more sustainability on cropping systems.

In the Mediterranean environment, the self-reseeding annual species of *Trifolium* and *Medicago* proved as cover crops, living mulches and green manures to be able to change the presently specialised cropping systems into more structurally complicated and sustainable ones (Lanini *et al*., 1989; Caporali *et al*., 1993a).

This paper presents the experimental results on aboveground biomass and nitrogen yield of several self-reseeding winter annual legumes to be used as green manures.

MATERIALS AND METHODS
The trial was carried out in the 1994-95 season at the experimental farm of Tuscia University (42° 26' N, 12° 4' E, altitude 310 m asl) on a hilly, volcanic soil (76.3% sand; 13.3% silt; 10.4% clay; pH 6.9; 1.32% organic matter; 0.096% total N). 20 self-reeseding legumes were sown in plots (15 m^2 each) on October 26, 1994, according to a completely randomized block scheme with 3 replicates. Three dates (30th March, 30th April and 30th May) for aboveground biomass harvest were set, each of which corresponded to a potential ploughing-in, in favour of early (like Sunflower), medium (like Corn) and late (like Tomato) summer crops. At each date, the DM weight and N content (determined according to the Kjeldhal method) of the aboveground biomass were recorded. The rainfall distribution in the season of growth (September 1994 - May 1995) was 120mm in the Autumn, 146 mm in the Winter, and 171mm in the Spring, denoting a wetter condition in comparison with the average pattern in Central Italy and therefore a year of higher productivity.

RESULTS AND DISCUSSION
The results in table 1 show a wide range of aboveground biomass production by the legumes, with the cultivars of *Medicago scutellata* ranking higher at every date of harvest and cumulating up to above 15 t/ha DM in the late harvest. Next come the cultivars of *Trifolium brachycalycinum* and *Trifolium yanninicum,* which show a similar potential of DM production (above 13 t/ha) for late green manuring, but with *T. brachycalycinum* performing better in the early harvest. Most of the cultivars of *T. subterraneum* rank lower, with biomass production of 8-11 t/ha DM. As a biomass producer, *M. scutellata* cv. Sava performed best from the early harvest, when it yielded more biomass than any other kind of *Trifolium* even at the medium harvest date, i.e. a month later. The diminishing values of aboveground biomass, as those recorded between the medium and late harvest in the case of *M. littoralis* can be explained by taking into account the dropping of leaves and fruits as litter to soil. For this reason, all the recorded values of biomass production are underestimated at the late harvest.

The biomass nitrogen content appears to be greatly affected by the age of the legumes and dramatically decreases between the medium and late harvest, when seed setting is occurring. The cultivars of the *Medicago* species generally show a more marked drop than those of *Trifolium*..

As a consequence of the aboveground biomass production and its nitrogen content, the potential contribution of nitrogen to soil by the legume green manures is shown in figure 1. The cultivars of *M. scutellata* appear to be the most powerful suppliers of nitrogen to soil, providing an average contribution of 200-300 kg/ha at each harvest time. The cultivars of *M.scutellata* appear particularly precious as early green manures because no other legume among those tested combines rapid growth with high nitrogen content as they do. As medium and late green manures, many of the *Trifolium* species and cultivars perform well and approximate *M.scutellata*'s performances.

These data confirm the astonishing productive capability of winter annual legumes as nitrogen fixing species in the Mediterranean environment during wet years. They could be even more extensively used if cropping systems were constructed with the aim of exploiting their self-reseeding capacity. In this prospective, cropping systems with self-reseeding legume intercropped with winter cereals should be established (Caporali and Campiglia 1993b, 1994) where the legume operates first as living mulch and then, after its reseeding and re-establishment in Autumn, as green manure for the subsequent summer crop. To accomplish those alternative and more sustainable cropping systems, there is the need to use legume cultivars with a low percentage of hard seed, which is more likely to occur for *Trifolium* than *Medicago* cultivars.

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Table 1
Legume aboveground biomass (DM) and nitrogen content (at different dates).

Species	cultivar	30th March		30th April		30th May	
		Biomass Kg/ha	Nitrogen %	Biomass Kg/ha	Nitrogen %	Biomass Kg/ha	Nitrogen %
Trifolium subterraneum	Daliak	2572	3.81	5625	2.48	8383	1.85
Trifolium subterraneum	Denmark	1913	3.78	4836	3.30	11436	2.04
Trifolium subterraneum	Gosse	4592	3.28	4551	2.56	9013	1.80
Trifolium subterraneum	Junee	2453	3.83	4336	3.24	8947	2.31
Trifolium subterraneum	Karridale	3077	3.83	4905	2.84	9493	2.51
Trifolium subterraneum	Nungarin	3650	3.25	4529	2.50	6492	2.24
Trifolium subterraneum	Seaton Park	3832	3.54	6879	2.53	11675	2.21
Trifolium subterraneum	Mount Barker	2078	3.75	3983	3.01	9525	2.05
Trifolium subterraneum	Dalkeith	2858	3.53	5151	2.64	6650	1.96
Trifolium brachycalycinum	Rosedale	4460	3.76	5654	3.16	11727	2.35
Trifolium brachycalycinum	Clare	4984	3.44	6265	3.34	13422	1.93
Trifolium brachycalycinum	Nuba	4887	3.75	6800	3.03	13350	2.48
Trifolium yanninicum	Larisa	2181	3.50	6057	3.41	13647	2.04
Trifolium yanninicum	Trikkala	2784	3.53	4739	2.83	13310	1.97
Medicago littoralis		3223	4.10	9593	3.27	8621	1.70
Medicago rugosa	Sapo	2048	3.89	4482	3.04	6436	1.77
Medicago truncatula	Parabinga	2421	4.14	3191	3.40	6074	1.91
Medicago truncatula	Sephi	4898	3.44	10585	3.09	10654	1.67
Medicago scutellata	Kelson	6802	3.49	9510	2.97	15753	1.89
Medicago scutellata	Sava	9037	3.19	13646	2.76	15217	1.55
LSD P£ 0.05		1599	0.35	2265	0.33	2719	0.27

Figure 1
Nitrogen in the aboveground biomass at different dates. H1 = early harvest (30th March); H2 = medium harvest (30th April); H3 = late harvest (30th May).