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ALTERNATIVE CROPPING SYSTEMS WITH SELF RESEEDING ANNUAL LEGUMES IN A MEDITERRANEAN ENVIRONMENT

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Abstract

Self-reseeding winter annual legumes (subclover and snail medic) have the potential to induce a significant shift towards a less energy-intensive and more environmentally friendly management in the modern and specialized cereal cropping systems. Nevertheless their use is practically unknown in mixed stands with winter cereals, where they can contribute to supply nitrogen and to reduce herbicides input. We conceived an alternative cropping system where an annual legume performs, respectively, as living mulch in a winter cereal (winter wheat), as a cover crop after reseeding and as dry mulch for the succeeding summer cereal (corn). Trials carried out at the Tuscia University (Central Italy) in the period 1995-1997 showed that almost all the tested legumes cultivars were able both to grow sufficiently as a living mulch in the wheat and to provide a good re-establishment and an abundant mulch after the wheat harvest for the next corn. *Trifolium yanninicum* cv Trikkala and *Trifolium subterraneum* cvs

Karridale and Mount Barker ranked first in reseeding capacity (up to 400 seedlings m^{-2}) and mulch production (up to 5 t ha^{-1}). No difference in grain yield between wheat with a living mulch and wheat in pure stand was found when legumes, such as *Trifolium yanninicum* cvs Trikkala and Larisa, *Trifolium brachycalycinum* cv Clare, *Trifolium subterraneum* cv Nungarin and *Medicago scutellata* cv Kelson, were grown in binary mixture with wheat. The aboveground biomass production of the succeeding irrigated corn crop was largely dependent on the amount of legume dry mulch left upon the ground.

Keywords: Cropping system, winter wheat, corn, self-reseeding, annual legumes, mulch

Introduction

Cash grain production systems in Central Italy, which involve winter cereals in rotation with summer crops as sunflower and corn, require high fertilizers and pesticides applications, with large input of fossil energy, a potential negative environmental impact, and increasing costs. Growing legumes has the potential to reduce the use of N fertilizers and herbicides in grain production. To be successful, the legume has to be integrated into cropping systems without bringing about changes into the crop sequence. Previous work has showed the possibility of improving wheat – sunflower rotation by intercropping a self-reseeding legume, which performs as living mulch in the wheat and as a green manure for the following sunflower (Caporali et al., 1993a; Caporali and Campiglia 1993b, 1994). In this study, we conceived a different cropping system where an annual legume performs as living mulch in a winter cereal and, after reseeding, as dry mulch for the succeeding summer cereal. The objectives of this research were: (i) to determine the best legume species to be used as a living mulch in the winter cereal and as a dead mulch for the following corn in a wheat-corn rotation; (ii) to evaluate the performances of a wheat intercropped with different legume living mulches; (iii) to determine the legume dry mulch effect on corn aboveground biomass.

Material and Methods

The trial was carried out during the 1995-97 period at the experimental farm of Tuscia University (42° 26' N, 12° 4' E, altitude 310 m asl) on a sandy-loam soil whose main characters were the following: 29.6 % clay, 23.1 % silt, 47.3 % sand; pH 6.7; 1.58 organic matter; 0.110 % total N (Kjeldhal). The experiment included the following treatments: (i) ten different self reseeding legumes (*Medicago scutellata* Mill. cv Kelson; *Trifolium subterraneum* L. cvs Nungarin, Gosse, Mount Barker, Denmark, Karridale; *Trifolium yanninicum* Katzn. cvs Larisa and Trikkala; *Trifolium brachycalycinum* Katzn. cvs Rosedale and Clare) fitted in a biennial winter wheat (*Triticum aestivum* L.) - corn (*Zea mais* L.) rotation as a persistent living mulch during the wheat season, as an useful cover crop during the following cold period (in fall and in winter) and as a dry mulch during the successive corn season; (ii) one conventional wheat - corn rotation (Figure 1). As pure stand systems, wheat and corn were sown in uniform rows, 15 cm and 50 cm apart, respectively. In the intercropping system wheat was sown in paired rows, in a 15 - 45 cm system, i.e., 2 wheat rows 15 cm apart and 2 such pairs 45 cm apart + legume sown in a band (30 cm wide) between the 2 pairs of wheat rows. The wheat seed rate in sole crop and intercrop was 250 and 500 seed m^{-2} respectively. The legume and corn seed rate was 150 and 9 seeds m^{-2} respectively. Dress fertilization applied just before wheat sowing (October 25th, 1995) consisted of 120 kg ha^{-1} P_2O_5 and no nitrogen was applied along the whole experiment. No weeding was necessary because of the unimportant weed development in both sole and mixed crops; corn was the only crop irrigated. Harvesting was carried out in July 1996 for wheat and in October 1997 for corn. When sampling for yield four rows of wheat and two rows of corn along four meters were harvested. Legume seedlings were counted in all the intercropped treatments just after emergence (October 1996) in 2 m^2 central plot, where aboveground biomass was also recorded just before corn sowing (June 3rd, 1997). Plant material was dried at 70 °C until constant weight. All the plots (each 6 x 6 m size) were arranged according to a randomized block design with 3 replicates.

The collected data were analyzed by one-way analysis of variance (ANOVA) using SAS (SAS Institute, 1993) followed by LSD test. In the table reported values followed by at least one letter in common do not significantly differ ($P \leq 0.05$) each other.

Results and Discussion

Results concerning wheat and corn yield, legume self-reseeding capacity and dry mulch production are showed in table 1. As far as wheat grain yield is concerned wheat intercropped with early cultivars of subclover (cv Nungarin, cv Larisa, cv Trikkala) and annual medic (snail medic) yielded as much as wheat sole crop, although the wheat seed rate in sole crop was double than that of intercrop (500 and 250 seed m^{-2} respectively). The other intercropped legumes significantly reduced ($P \leq 0.05$) wheat grain yield from 18 % to 31 %. This difference in grain performance can be likely attributed to the lower competitive capacity associated with the shorter life cycles of the early legumes intercropped. The legume dry mulch production was largely affected by the reseeding rate. The cultivar that provided the best reestablishment at first reseeding (509 seeds m^{-2}) and consequently, the most abundant mulch production (7.58 t ha^{-1}) was subclover cv Trikkala. The aboveground biomass production of the succeeding irrigated corn crop was generally dependent on the amount of legume dry mulch left upon the ground. The best corn performance both for cob and aboveground biomass production was recorded with subclover cv Trikkala as a dry mulch (9.91 and 20.03 t ha^{-1} respectively). Another legume cultivar that performed well both in wheat and corn was subclover cv Larisa.

Both cultivars of subclover Trikkala and Larisa belong to *Trifolium yanninicum* which is a species better adapted to wetter and acid soils than *Trifolium subterraneum* and *Trifolium brachycalycinum* (Francis et al., 1974; Piano et al., 1982).

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Table 1 - Characters of wheat, legumes and corn in the different cropping systems.

Cropping system	Wheat		Legumes		Corn	
	Grain yield	Harvest index	Seedlings from reseeding	Dry mulch	Cob	Aboveground Biomass
	$t\ ha^{-1}$ DM	%	n° m^{-2}	$t\ ha^{-1}$ DM	$t\ ha^{-1}$ DM	$t\ ha^{-1}$ DM
Wheat + snail medic cv Kelson	3.17 a	36 a	98 de	2.24 d	8.33 bc	17.40 ad
Wheat + subclover cv Nungarin	3.15 a	35 ab	144 d	2.10 d	7.77 cd	15.54 ce
Wheat + subclover cv Larisa	3.12 a	36 a	315 c	4.15 c	9.28 ab	18.06 ac
Wheat + subclover cv Trikkala	3.07 a	34 ab	509 a	7.58 a	9.91 a	20.03 a
Wheat (sole crop)	2.89 a	28 cd	-	-	7.38 cd	14.97 de
Wheat + subclover cv Clare	2.82 ab	36 a	112 de	2.30 d	9.81 a	17.93 ac
Wheat + subclover cv Gosse	2.37 bc	35 ab	273 c	4.43 c	7.82 cd	17.18 bd
Wheat + subclover cv Mount Barker	2.18 c	36 a	401 b	5.79 b	9.09 ab	18.26 ab
Wheat + subclover cv Denmark	2.14 c	25 d	84 e	1.25 e	8.91 ab	17.52 ad
Wheat + subclover cv Karridale	2.11 c	31 dc	429 b	6.14 b	7.08 d	14.20 e
Wheat + subclover cv Rosedale	1.98 c	32 ac	92 e	1.34 e	7.00 d	15.01 de

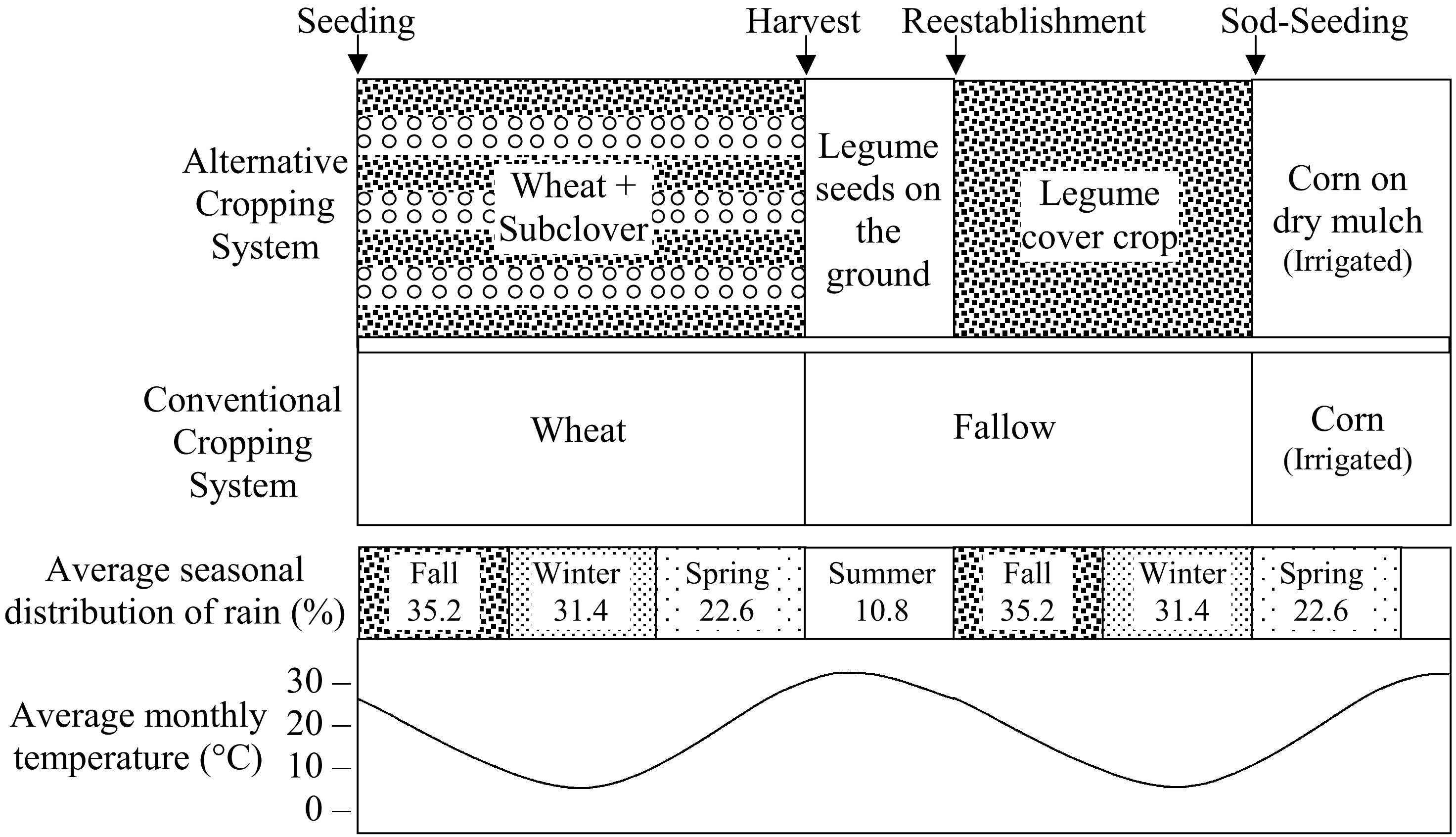

Figure 1 – Experimental layout in temporal sequence