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Alfalfa intercropping and competitive ability

by Paolo ANNICCHIARICO¹, Bernadette JULIER^{2*}, Gaëtan LOUARN² and Amel MAAMOURI²

Abstract: Alfalfa is subjected to interspecific competition in two situations: (i) intercropping with a forage grass, where the required long-lasting equilibrium between species is frequently threatened by excessive alfalfa competitive ability; (ii) competition against weeds, which can be severe in monoculture and requires high competitive ability to avoid any chemical weed control. In both cases, competition for light interception is the main mechanism that drives the species proportion. Vegetative vigour and plant architectural traits can affect the alfalfa competition dynamics across successive harvests. Once completely unveiled, these traits could be selected for new varieties with improved adaptation to competition.

Key words: interspecific interference, legume-grass mixtures, organic agriculture, plant competition, weed competition

Introduction

Our focus on alfalfa competitive relationships is two-fold here, i.e.: (i) intercropping with a grass companion, to obtain a long-lasting, balanced mixture of the two components of the mixture; (ii) competition against weeds, to avoid any chemical weed control. Legume-grass mixtures are gaining new interest in Europe and elsewhere, owing to the energy and environmental costs associated with the synthesis and use of nitrogen fertilizer required for grass forage production and the quest for greatest self-sufficiency in feed proteins at the farm and the country levels. Legume-grass mixtures are currently grown over 70% of the sown grassland in France, exploited as hay, silage or grazed forage. Alfalfa monoculture is still prevalent in other countries, e.g. Italy, where it is the backbone of organic crop-livestock systems and contributes significantly to conventionally managed systems. Alfalfa competitive ability against weeds is crucial for organic systems and increasingly important for conventional ones, especially for the pure stand.

We briefly review alfalfa competitive relationships mainly with respect to their relevance to breeders. One major issue in this context is whether alfalfa varieties targeted to mixed cropping with grasses, or targeted to cropping under severe weed competition (as in most organic systems), could be successfully selected or recommended from testing trials carried out in the simpler condition of absence of competition. The response, which depends on the degree of genetic correlation between selection and target environments, has far-reaching implications, e.g. for the choice of phenotyping conditions in marker-assisted selection studies, or procedures for assessing the variety value for cultivation and use.

Competition

Alfalfa-grass intercropping and weed-invaded alfalfa crops are situations of interspecific plant competition which imply different targets. The target is maintaining a desirable legume-grass balance in the former case, and excluding the weeds in the latter. Competition for resources is one of the major processes controlling plant growth and explaining the dynamics of plant mixtures. Competition for light is of primary importance, because it determines the energy available for all physiological processes and

partially drives the acquisition of other resources. Furthermore, as light availability declines exponentially with the distance from the top of the canopy, minor differences in plant size can have major effects on the relative yield of the intercropped species. The amount of captured light defines the potential growth rate and the nitrogen demand of the crops. Besides energy capture and photosynthesis, competition for water and nutrients is also critical in explaining the dynamics of plant mixtures.

Competitive ability and compatibility with grasses

The companion grass tends to be at competitive disadvantage and less persistent than alfalfa when associated with highly productive alfalfa varieties under favourable cropping conditions, while the reverse may occur when alfalfa is grown in shallow soils or suffers from poor establishment.

In alfalfa, traits related to growth habit, shoot development and branching (leaf area expansion), and internode length (vertical leaf area distribution) showed a prominent role in light interception, and mainly contribute to its advantage compared to grasses (4). For legumes

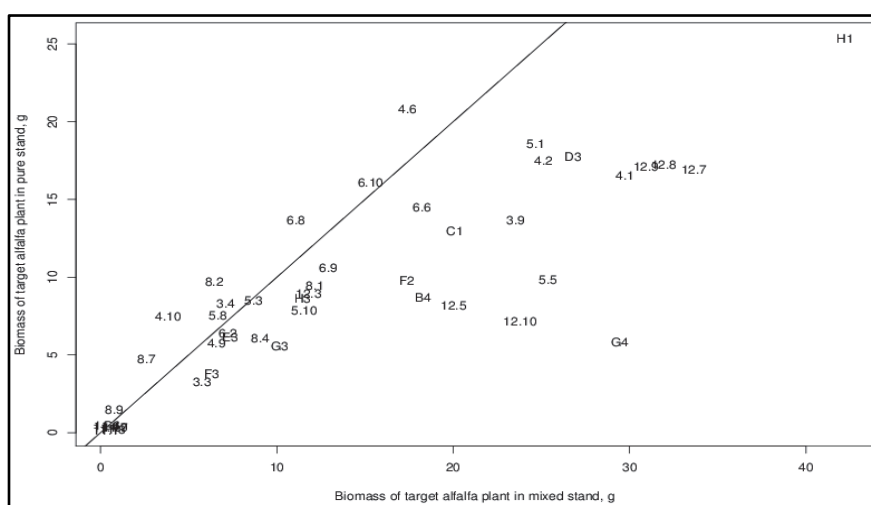


Figure 1. Biomass yield in the first harvest of 2011 of alfalfa genotypes grown in mixtures (one target alfalfa plant surrounded by 2 alfalfa and 4 tall fescue plants) and in pure stands (one target alfalfa plant surrounded by 6 alfalfa plants from the tall, erect cultivar Orca); the line is for equal biomass production in both stands

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