Relationships between productivity, quality and traits in seven co-occurring grass species

L.S. Pontes[1], J.F. Soussana[1], P. Carrère[1], F. Louault[1], J. Aufrère[2] and D. Andueza[2]
[1]INRA, Unité d'Agronomie, Clermont-Ferrand, France. Email: lpontes@clermont.inra.fr, [2]INRA, Unité de Recherche sur les Herbivores, Theix, France.

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Introduction The impacts of management options sometimes have dramatic effects on botanical composition which in turn affect yield and nutritive value. A functional analysis of vegetation response may help to understand and predict the impact of changes in grassland management in a more general way screening for plant traits that may control productivity and nutritive value.

Materials and methods Monocultures of *Anthoxanthum odoratum (Ao), Dactylis glomerata (Dg), Elymus repens (Er), Festuca rubra (Fr), Holcus lanatus (Hl), Lolium perenne (Lp)* and *Poa pratensis (Pp)* were grown at two cutting frequencies (3 and 6 cuts per year; C- and C+) and at two levels of inorganic N supply (120 and 360 kg N $ha^{-1}yr^{-1}$; N- and N+) in a complete block design with 3 replicates at Theix (900 m a.s.l., Massif-Central, France). In spring and summer, plant traits were measured after 3 weeks of regrowth on 10 tillers selected at random: elongated plant height (PHe), sheath length (SL), number of growing (NG) and of mature (NM) leaves. After rehydration, the length (LL), area (LA) and fresh mass (LFM) of the youngest fully expanded leaf were measured. Leaf dry matter content (LDMC) and specific leaf area in dry matter (SLA) were then calculated. Leaf lifespan (LLS) and phyllochron (Ph) were determined in labelled tillers. Aboveground DM yield (Y) and the tiller density per unit of ground area (TD) were measured at the cutting date, and the nutritive value of the cut herbage was estimated. Forage samples were analysed for *in vitro* dry matter digestibility (IVDMD) (pepsin-cellulase, Aufrère & Demarquilly, 1989) and fibre fractions (NDF and ADF) (Goering & Van Soest, 1970) via near-infrared reflectance spectroscopy (NIRS). Soluble cellular content (1-NDF) (C1), hemicellulose (NDF-ADF) (C2) and cellulose plus lignin (ADF) (C3) were calculated from the fibre fractions. Relationships between production, quality and traits were assessed by simple correlations and through principal components analysis.

Results Traits describing tiller and leaf size were most strongly correlated to DM yield (Figure 1). Large grasses (e.g. *Dg*) with a low tiller density and a short leaf lifespan were most productive. Digestibility (DMD) was positively correlated with SLA (r=0.49) and negatively correlated with LDM (-0.54). As expected, DMD was positively correlated with C1 and negatively correlated with C2 and C3. Grasses with high tiller density (*Fr* and *Pp*) displayed a low nutritive value (r=-0.44). The data also show that both DM yield and digestibility were positively related to with SL (r=0.40, r=0.46). All correlations were highly significant (P<0.001).

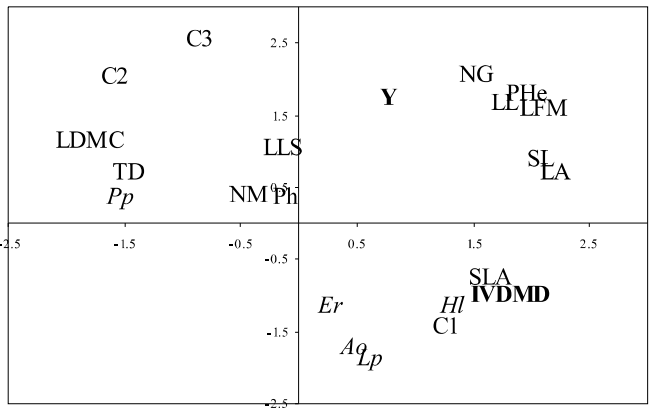

Figure 1 Projection of traits, agronomic characteristics (in bold) and species (italic) in the plan formed by the first two components of a PCA (axis 1 = 42%; axis 2 = 27%). Each value is the mean of 12 plots (four treatments).

Conclusions The first axis of the PCA appears to contrast competitive (large size, productive, high SLA, low LDM, low TD) and conservative grasses. The second axis indicates a trade-off between productivity and quality, by opposition between yield and related traits (such as tiller, sheath and leaf size) on the one hand, and DMD and SLA on the other. For the species studied, leaf and stem size were good predictors of aboveground productivity, while SLA and LDM of leaves were good predictors of DMD. These preliminary conclusions will be further tested on more species by analysing the coupled changes in traits, productivity and quality in relation to grassland management (cutting frequency and N supply) and species diversity (comparing monocultures and mixtures).

References

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