Perennial ryegrass variety ranking responses to inclusion of white clover and altered nitrogen fertility

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Abstract

Perennial ryegrass (*Lolium perenne*) is the most widely used ryegrass species for high-output pasture based dairy farms in Europe. Repeated selective breeding has enhanced dry matter (DM) productivity potential, elevated nutritive value and provided a large diversity of varieties adapted to variant growing conditions and farming practices. With renewed interest in white ryegrass-clover swards mixtures, there is a concern that sward interactions between perennial ryegrass varieties and white clover will have a significant effect on the dry matter yield performance of a recommended grass variety. The aim of this study was to establish if perennial ryegrass varieties re-rank in DM yield when sown with/without white clover at two nitrogen applications under intensive grazing. Eight perennial ryegrass varieties were sown with (+C) /without (-C) white clover. Swards received two levels of nitrogen 250 (HN) and 100 (LN) kg N ha^{-1}. Treatments were HN+C, HN-C, LN+C and LN-C. A significant nitrogen by clover interaction occurred because LN-C gave the lowest yield, but although high nitrogen increased both the with and without clover treatments, the highest yielding treatment was LN+C. Grass variety had a significant effect *(P*>0.001*)* on DM yield, but the ranking of the ryegrass varieties was unaffected by the imposed treatments and so represented a robust estimation of the relative DM production potential of each ryegrass variety. The inclusion of clover also did not affect the relative performance of the ryegrass varieties, indicating that any inter-species competitive interactions were not variety specific.

Keywords: dry matter, perennial ryegrass, white clover, nitrogen, intensive grazing

Introduction

Perennial ryegrass (*Lolium perenne*) (PRG) is the most widely used forage grass in North-Western Europe (Wilkins and Humphreys, 2003). With the intensification of agriculture throughout Europe, the ability of farmers to increase forage yield, through increased fertiliser inputs is limited (Parsons *et al.*, 2011). The inclusion of white clover in perennial ryegrass pastures has been shown to increase herbage and animal performance production while reducing artificial N inputs. In Europe, perennial ryegrass varieties are generally evaluated in monoculture swards under a mechanically harvested, simulated grazing protocol with high levels of N fertiliser (e.g. 350 kg N ha^{-1} year^{-1}; DAFM, 2010). However, on farm, PRG swards are grazed directly by animals and often sown in a mixture with white clover (WC) under reduced N inputs. As perennial ryegrass and white clover can interact in a mixed sward (Camlin, 1981), it is important that grass varieties are ranked according to the conditions under which they are used to ensure that the best-adapted and highest performing can be identified. If ryegrass varieties interact differently with white clover and, if this is modified by fertility levels, then grass variety evaluations will need to account for this variable when making recommendations. Therefore, this study was designed to compare the relative dry matter (DM) performance of perennial ryegrass varieties with and without white clover at two nitrogen inputs under intensive cattle grazing.

Materials and methods

An experiment was established in June 2012 at the Animal and Grassland Research and Innovation Centre, Moorepark, Co. Cork, Ireland. The experiment was a randomised block design with a 2×2 factorial arrangement of treatments with 5 replicates of 18×3 m plots. Eight perennial ryegrass varieties (4 diploids and 4 tetraploids) were sown as grass-only (-C) or grass with WC (+C). Two fertiliser N rates were applied: 100 (low) and 250 (high) kg N ha^{-1}. Sowing rates were 37 kg ha^{-1} for the tetraploid varieties and 34 kg ha^{-1} for the diploid varieties while the medium leaf WC, Crusader was included in the +C plots at 5 kg ha^{-1}. Treatments were high nitrogen sown without clover (HN-C), high nitrogen sown with clover (HN+C), low nitrogen sown without clover (LN-C), and low nitrogen sown with clover (LN+C). Rotation length was adjusted depending on the N application (HN – 21 days; LN – 30 days). Plots were grazed by dairy cattle to a target post-grazing residual height of 4 cm in the first year. Experimental measurements commenced in March 2014, employing the same grazing strategy. Dry matter yield was estimated in each plot by cutting a strip (approx. 5×1.2 m) with an Etesia mower. Harvested herbage was weighed and a subsample of 100 g was used to determine DM content. There were nine grazing rotations on the HN plots and seven grazing rotations on the LN plots from 18 March to 14 October 2014. Seasonal yields composed of spring (March-April), mid-season (May-July) and autumn (August-October). Data were analysed using PROC MIXED in SAS (version 9.3) with block, treatment, variety and their interactions tested for in the model.

Results and discussion

The grass varieties differed significantly (P<0.001) in annual DM yield (Figure 1). When averaged across all treatments, the range was from Glenveagh (12,140 kg DM ha^{-1}) to Aston Energy (9,870 kg DM ha^{-1}). With such a wide but progressive range in performance, it would be expected that if varieties reacted differentially to the imposed treatments then this could be detected within this yield range. Furthermore, a significant nitrogen by clover interaction occurred between treatments (P<0.001), due to LN-C giving the lowest yield, but while high nitrogen gave greater yields with and without clover, the highest yield of all was from LN+C (Table 1). This was evident in the total annual yields (LN-C 9,126 kg DM ha^{-1} and LN+C 13,021 kg DM ha^{-1}) and also in each seasonal period. This response also meant that there was no significant difference between nitrogen treatments (HN-C and HN+C vs LN-C and LN+C) in total annual yield or in spring or summer productivity. In the autumn period HN did out yield the LN (P<0.01) possibly due to the LN-C sward receiving insufficient N with a response of 26 kg DM per additional kg N in favour of the HN-C treatment creating a greater difference between treatments. Despite all these significant responses, there was no interaction between variety ranking and treatment in seasonal or annual DM yields, indicating that the relative performance of the eight varieties was not differentially affected by either altering the nitrogen fertility or by including white clover into the sward. These findings are similar to previous reports by McDonagh *et al.* (2014) and Rossi *et al.* (2014). The degree of resilience in rank order was despite the absolute DM yields changing significantly between

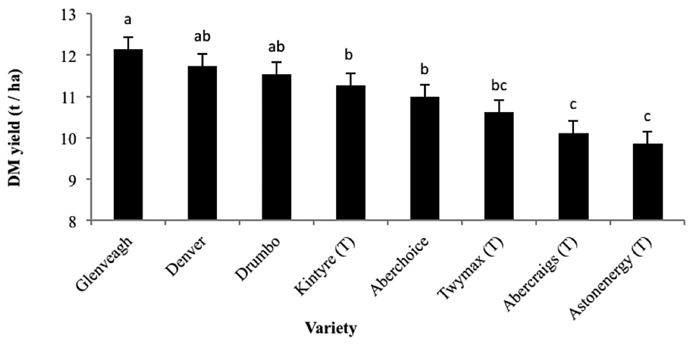

Figure 1. Annual range in dry matter (DM) yield of eight perennial ryegrass varieties as an average of the clover and nitrogen treatments. T = tetraploid variety; bars with different letters (a-c) differ at P<0.05.

Table 1. Effect of nitrogen, clover and their interaction on dry matter (DM) yield of perennial ryegrass varieties.[1,2,3]

	HN-C	HN+C	LN-C	LN+C	SED	N	Clover	N × Clover
Annual (kg DM ha^{-1})	10,554[a]	11,450[b]	9,126[c]	13,021[d]	202	NS	***	***
Spring (kg DM ha^{-1})	2,052[a]	2,221[b]	1,944[a]	2,486[c]	78	NS	***	***
Summer (kg DM ha^{-1})	6,283[a]	6,763[b]	5,503[c]	7,912[d]	166	NS	***	***
Autumn (kg DM ha^{-1})	2,220[a]	2,466[b]	1,678[c]	2,623[d]	42	**	***	***

[1] HN = 250 kg N ha^{-1}; LN = 100 kg N ha^{-1}; +C / -C = with/without white clover.; SED = standard error of the diference.

[2] Means within a row with different superscripts differ (P<0.05).

[3] NS = not significant; * P<0.05, *** P<0.001.

treatments (P<0.001) (Table.1), with the greatest difference occurring in the mid-season period (+2,403 kg DM ha^{-1}) when clover content peaked (data not shown).

Conclusions

The results from this study indicate that for the perennial varieties examined, their relative DM productivity ranking is not modified when white clover is introduced into the swards and this resilience is maintained even when nitrogen levels are also substantially changed. This indicates that it is not necessary to have separate testing protocols to assess the DM yield potential perennial ryegrass varieties for use in grass-only and mixed grass-clover grassland systems.

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