The effect of tetraploid and diploid perennial ryegrass swards sown with and without clover on milk and herbage production

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Abstract

An experiment to investigate the impact of tetraploid and diploid perennial ryegrass swards sown with and without white clover on the productivity of spring milk production systems was established in 2012 (75%) and 2013 (25%). Four separate grazing treatments/swards were sown for the experiment: tetraploid only, diploid only, tetraploid with clover and diploid with clover. Eight cultivars (four diploid: Tyrella, Aberchoice, Glenveagh and Drumbo; four tetraploid: Aston Energy, Kintyre, Twymax and Dunluce) were sown as monocultures with and without clover. Thirty cows were allocated to each treatment after calving in February 2014. All treatments were stocked at 2.75 cows ha^{-1} and received 250 kg of nitrogen fertiliser ha^{-1}. There was no difference in milk or milk solids yield between the tetraploid-only (4,895 and 414 kg cow^{-1}, respectively) and diploid-only (4,848 and 403 kg cow^{-1}, respectively) swards. However, incorporating clover resulted in 13.3% greater milk yield and 13.4% greater milk solids yield (5,532 and 464 kg cow^{-1}, respectively, and 5,506 and 462 kg cow^{-1}, respectively, for the tetraploid with clover and diploid with clover treatments, respectively). Pasture dry matter (DM) production was 16.8% greater on the grass-clover swards (17,400 kg DM ha^{-1}) compared to the grass-only swards (14,900 kg DM ha^{-1}).

Keywords: white clover, grazing, dairy cow, milk production

Introduction

Worldwide demand for dairy products is increasing and pasture-based systems have the potential to produce increased volumes of high quality dairy products post-European Union milk quota abolition in 2015 (Lips and Rieder, 2005). The utilisation of increased quantities of grazed pasture at farm level will provide the basis of these sustainable livestock systems. Research has indicated that grass cultivars can affect milk production: Wims *et al.* (2013) reported that cows grazing tetraploid perennial ryegrass monoculture swards produced more milk than cows grazing diploid swards. There is renewed interest in forage legumes, particularly white clover (*Trifolium repens* L.), as it offers important opportunities for sustainable pasture-based animal production systems by (1) increasing pasture yield, (2) increasing pasture nutritive value and raising the efficiency of conversion of herbage to animal protein, (3) substituting inorganic nitrogen (N) fertiliser with symbiotic N fixation, and (4) mitigating and facilitating adaption to climate change (Lüscher *et al.*, 2014). Research has also shown the benefit of grass-clover over pure perennial ryegrass (*Lolium perenne* L.) swards for milk production, particularly in the second half of lactation (Harris *et al.*, 1997; Riberio Filho *et al.*, 2003). Therefore, the objective of this study was to evaluate the effect of tetraploid and diploid cultivars of perennial ryegrass, with and without clover inclusion, on the productivity of spring-calving milk production systems.

Materials and methods

A grazing experiment was established at Clonakilty Agricultural College (51°6N; 8°85W) in 2012 and 2013. 75% of the experimental area was reseeded in 2012 and 25% reseeded in 2013. The experimental design was a randomized complete block with a factorial arrangement of treatments, i.e. two grass ploidies (tetraploid and diploid) × two clover treatments (clover and no-clover), resulting in four treatments (tetraploid only (T); diploid only (D); tetraploid + clover (TC); and diploid + clover (DC)). There

were 30 cows per treatment group and all treatments were stocked at 2.75 cows ha^{-1} and received 250 kg N ha^{-1}. Each treatment had a separate farmlet of twenty paddocks. To create the farmlets, twenty blocks of paddocks (each block contained four paddocks (80 paddocks in total)) were created and four diploid (Tyrella, Aberchoice, Glenveagh and Drumbo) and four tetraploid (Aston Energy, Kintyre, Twymax and Dunluce) cultivars were sown as monocultures with and without clover in five different blocks around the experimental area. In the clover paddocks a 50:50 mix of Chieftain and Crusader clover was sown at a rate of 5 kg ha^{-1}. There were 120 dairy cows, comprising three breeds (Holstein-Friesian (HF), HF × Jersey (J) and Norwegian Red × HF × J), which were randomly assigned to one of four herds based on breed, calving date, parity and pre-experimental milk yield. Each herd was then randomly assigned to one of the four treatments. The four treatments were rotationally grazed from mid-February until mid-November 2014. Each farmlet was walked weekly to monitor average farm cover (O'Donovan, 2000) and when surpluses were identified they were removed in the form of baled silage. If a feed deficit occurred across all treatments, then all treatments were supplemented with concentrate. If a deficit occurred in an individual treatment then cows were supplemented with conserved forage produced from within that treatment. Sward clover content was estimated pre-grazing by cutting herbage within a quadrat (0.5×0.5 m) to 4 cm and separating a 70 g sample into grass and clover fractions and drying at 90°C for 15 hours to get the sward clover dry matter (DM) content. Sward clover content was not measured in February and March. Individual milk yields (kg) were recorded at each milking. Milk composition was measured weekly from a consecutive AM and PM milking. Milk and pasture production data were analysed using General Linear Models (PROC GLM) in SAS (SAS, 2006). Terms included in the model were ploidy, clover content and their interactions. Parity and breed were also included in the milk analysis.

Results and discussion

Sward clover content was 39 and 40% for TC and DC, respectively. Ploidy approached significance (P=0.056) for daily herbage allowance (HA). There was a tendency for diploid treatments (D and DC) to have greater HA (16.3 kg DM cow^{-1} compared with the tetraploid treatments (T and TC; 15.1 kg DM cow^{-1}). Clover did not affect HA (16.1 kg DM cow^{-1} for T and D vs 15.4 kg DM cow^{-1} for TC and DC). Milk production results for 2014 are presented in Table 1. Ploidy did not affect any of the milk production variables. Clover inclusion had an effect (P<0.001) on both daily and cumulative milk and milk solids yield per cow. Cows grazing both the TC and DC had 13.3 and 13.4% greater cumulative milk and milk solids yield cow^{-1}, respectively, compared with T and D. Fat content was not affected by clover content; however, there was an effect (P<0.01) on lactose content, while protein content approached significance (P=0.052) for clover swards. Pasture DM production was 16.8% greater on the grass-clover swards (17,400 kg DM ha^{-1}) compared with the grass-only swards (14,900 kg DM ha^{-1}).

Table 1. Effect of grass ploidy (P) and white clover (C) inclusion on milk production in 2014.[1]

	Sward treatment				SE	*P*	C	P × C
	T	D	TC	DC				
Milk yield (kg cow^{-1} day^{-1})	17.7	17.5	20.0	20.0	0.28	0.765	<0.0001	0.881
Milk solids (kg cow^{-1} day^{-1})	1.50	1.46	1.68	1.67	0.025	0.418	<0.0001	0.495
Fat (g kg^{-1})	47.4	47.0	46.5	46.8	0.73	0.935	0.457	0.725
Protein (g kg^{-1})	37.3	36.5	37.5	37.5	0.30	0.158	0.052	0.117
Lactose (g kg^{-1})	47.6	47.4	47.9	48.2	0.14	0.582	0.002	0.178
Cumulative milk yield (kg cow^{-1})	4,895	4,848	5,532	5,506	63.7	0.708	<0.0001	0.914
Cumulative milk solids (kg cow^{-1})	414	403	464	463	5.5	0.407	<0.0001	0.520

[1] T = tetraploid grass; D = diploid grass; TC = tetraploid grass + clover; DC = diploid grass + clover; SE = standard error.

Ploidy did not affect pasture DM production or milk production, but there was a significant increase in these parameters when clover was included. Similar to Riberio Fihlo *et al.* (2003), increased daily milk yield was observed for cows that grazed grass-clover swards compared with grass-only swards. Harris *et al.* (1997) indicated that the proportion of clover in pasture needs to be greater than 20% in order to see an animal production effect. Therefore, the high clover content in the current study was the reason for the significant increase in pasture DM and milk production.

Conclusions

White clover incorporation appears to offer an opportunity to increase pasture DM production and increase animal performance. However, the results presented are from year one of the experiment and further research is required as to the long-term effectiveness, persistency and sustainability of clover in Irish grazing systems.

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