Dry matter yields and nutritive value of silage from cereal and pea combinations

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Abstract

Winter forage cereals offer potential on dryland dairy farms for both grazing and ensiling, but the nutritive value of resultant silage for lactating dairy cows is not well defined. This study evaluated the potential of growing peas in combination with forage cereals to improve the nutritive value of silage whilst maintaining dry matter (DM) yields.

Wheat (cv. Wedgetail) or triticale (cv. Crackerjack) were grown in a range of combinations with peas (cv. Kaspa). Treatments were 100% cereal or pea and combinations of cereal and pea (P) at 75:25, 50:50 and 25:75 with ratios based on sowing rate. Dry matter yields and nutritive value were assessed when cereals reached GS 45 and 84 and the nutritive value of silages made at GS 84.

At GS 45, DM yield of the P100 treatment was less ($P<0.05$) than for all other treatments. At GS 84 there were no DM yield differences between the P100 treatment and wheat (W) treatments. However, all triticale (T) treatments except T25P75 had higher ($P<0.05$) DM yields than the P100 treatment. At GS 84, the crude protein (CP) and estimated metabolisable energy (ME) of P100 were higher ($P<0.05$) and the neutral detergent fibre (NDF) content lower ($P<0.05$) than for all other treatments. The ME of T100 was higher ($P<0.05$) and NDF lower ($P<0.05$) than the W100 treatment. The CP and ME of P100 silage was higher ($P<0.05$) and the NDF lower ($P<0.05$) than for all other treatments, whilst the CP content of all cereal/pea combinations was higher ($P<0.05$) than the T100 or W100 treatments. Results indicate that sowing peas with cereals has the potential to improve nutritive value but may result in lower DM yields. Therefore, there may be merit in growing forage cereals and peas as monocultures and develop strategies to subsequently mix prior to ensiling.

Key words

Wheat, triticale, peas, crude protein, silage

Introduction

To be competitive in the Australian dairy industry, farmers need to improve the efficiency of conversion of inputs to the farm business into outputs, reducing the overall cost of production of milk and improving profitability. Sustainable improvements in profitability of southern Australian dairy farms can be achieved by increasing the amount of forage grown and consumed on-farm and the strategic use of bought-in supplements to support milk production during deficits in farm grown of energy and protein. Existing ryegrass based pasture systems experience feed deficits in winter and summer and alternative strategies to increase on-farm forage production to even out the seasonal distribution of forage production are required whilst maximising use of the ryegrass pasture base (Chapman *et al.* 2006). Winter cereals offer the potential of a high yielding crop that can be grazed and subsequently cut for silage. The potential of using cereal crops for both winter grazing and silage in New Zealand was highlighted by De Ruiter *et al.* (2002). However the nutritive value after anthesis is at best medium to low (Moreira 1989) and may limit the use of such silages in the diets of lactating dairy cows. Previous work (Jacobs and Ward 2008) has shown that DM yields of 15 – 20 t DM/ha are achievable for cereal crops cut at soft dough (GS 84), but the resultant metabolisable energy (8.6-9.1 MJ/kg DM) and crude protein (8.4-10.9 %DM) are relatively low. One option to improve the nutritive value of whole crop silage would be to include a legume at sowing, although this has the potential to reduce total DM yield. This experiment was established to determine the effect of including field peas at a range of rates with either wheat or triticale on DM yield, nutritive value of the standing crops and also the impact on the nutritive value of resultant silages.

Methods

Site preparation and design

This experiment was conducted on a commercial dairy farm (DemoDAIRY) (38^{o} 14' S; 142^{o} 55'E) in south west Victoria. The soil, a fine sandy clay loam is described as a brown chromosol (Isbell 1996) derived from quaternary basalt. In early April 2007, the experimental areas were sprayed with a mixture of Roundup Max at 3 L/ha (540 g/L glyphosate), Dicamba 500 mL/ha (500 g/L dicamba) and Le-Mat 100 mL/ha (290 g/L omethoate) to kill emerging weeds and reduce any existing population of red-legged earth mite. On 7 May the experimental sites were sown by direct drilling using a Cross Slot No Till machine with 100 kg/ha DAP (18 kg N, 20 kg P) drilled in at sowing then 375 kg/ha of 2&1 super potash (22.1 kg P, 62.6 kg K, 27.4 kg S) was broadcast over the experimental area. Wheat (W)(cv Wedgetail) or triticale (T)(cv Crackerjack) were sown in a range of combinations with peas (P)(cv Kaspa) in a randomised block design with four replicates of each treatment. Treatments were 100% cereal (W100; T100) or pea (P100) and combinations of cereal and pea at 75:25 (W75P25; T75P25), 50:50 (W50P50; T50P50) and 25:75 (W25P75; T25P75) with ratios based on sowing rate (137 kg/ha). Additional N (100 kg N/ha) was applied to all treatments when the cereal crops reached GS 32.

Measurements

At GS 45 (wheat 3 October; triticale 19 September) and at GS 84 (15 November), 10 cuts of plant rows each side of a 50 cm rod were taken per plot and DM yield determined. Samples were bulked on a plot basis and sub-sampled for DM content and nutritive characteristics. Forage samples were analysed by FEEDTEST, Department of Primary Industries, Hamilton, Victoria, for crude protein (CP) (nitrogen concentration x 6.25), neutral detergent fibre (NDF) and dry matter digestibility (DMD). Values were estimated for all samples using near infrared spectroscopy (NIR). Estimated metabolisable energy (ME) (MJ/kg DM) values were calculated from predicted DMD values using the formula:

$$ME = [0.164\ (DMD\% + EE) – 1.61]$$

where EE = Ether Extract (% of DM) was assumed to be 2% for all fodders (AFIA 2002). When the cereal component of the crops reached GS 84, they were harvested using a precision chop forage harvester and samples taken to ensile in small laboratory scale 4 kg silos. Material for each treatment was ensiled either untreated or with one of two additives (LaSil or Sil-All 4x4). Silos were opened 120 days after ensiling and samples analysed for DM content and nutritive characteristics using the methods outlined above with DM content corrected for volatiles according to the method of AFIA (2002). Analysis of variance was undertaken using Genstat (GenStat Committee 2003).

Results

DM yields

At GS 45, DM yield of the P100 treatment was less ($P<0.05$) than for all other treatments (Table 1). In addition the T100 had a higher ($P<0.05$) DM yield than either the T25P75 or T50P50 treatments. At GS 84 there was no difference between the P100 treatment and all wheat treatments. However, all triticale treatments except T25P75 had higher ($P<0.05$) DM yields than the P100 treatment.

Table 1. Dry matter (DM) yields (t DM/ha) and growth rates (GR) (kg DM/ha/d) for triticale (T), wheat (W), peas (P) and cereal/pea combinations at GS 45 and GS 84

	Triticale GS 45		Wheat GS 45		GS 84	
	DM yield	GR sow to GS 45	DM yield	GR sow to GS 45	DM yield	GR GS45 to GS 84
T100	7.55	55.9			15.61	146.7
T75P25	7.41	54.9			18.01	192.6
T50P50	6.54	48.5			16.36	178.5
T25P75	6.73	49.8			13.71	127.0
P100	4.54	33.6	5.16	37.2	12.06	136.8
W100			7.44	49.9	13.52	148.5
W75P25			7.17	48.1	12.51	130.1
W50P50			6.82	45.8	13.30	158.1
W25P75			6.61	44.3	13.52	108.8
LSD (P=0.05)	0.743	5.50	1.013	6.03	2.603	56.08

At GS 45, the CP of P100, T25P75 and W25P75 were higher ($P<0.05$) than either T100 or W100, whilst the NDF content of P100 was lower ($P<0.05$) than the 100% cereal treatments (Table 2). At GS 84 the CP and ME of P100 was higher ($P<0.05$) and the NDF lower ($P<0.05$) than for all other treatments. Apart from the 75% pea treatments, the CP of wheat treatments was higher ($P<0.05$) than the corresponding triticale treatments. The ME of T100 was higher ($P<0.05$) and NDF lower ($P<0.05$) than the W100 treatment. The WSC of P100 was lower ($P<0.05$) than all other treatments, whilst all triticale treatments had higher ($P<0.05$) levels than the corresponding wheat treatments. The treatments containing 75% peas also had lower ($P<0.05$) WSC contents than the 100% cereal treatments.

The CP and ME of P100 silage was higher ($P<0.05$) and the NDF lower ($P<0.05$) than for all other treatments (Table 3), whilst the CP content of all cereal/pea combinations was higher ($P<0.05$) than the T100 or W100 treatments. The ME of T50P50 and T25P75 was higher ($P<0.05$) than for T100. The CP content of wheat silages increased ($P<0.05$) with increasing pea content. All wheat treatments had higher ($P<0.05$) CP and ME than their corresponding triticale treatments. The Sil-All 4x4 treated silages had a higher ($P<0.05$) CP than either the untreated or the LaSil treated silages, whilst ME content of Sil-All 4x4 treated silages was higher ($P<0.05$) than for LaSil treated silages.

Table 2. Crude protein (CP) (% DM), metabolisable energy (ME)(MJ/kg DM), neutral detergent fibre (NDF) and water soluble carbohydrate content (WSC)(% DM) of triticale (T), wheat (W), peas (P) and cereal/pea combinations at GS 45 and GS 84

	GS 45				GS 84			
	CP	ME	NDF	WSC	CP	ME	NDF	WSC
T100	15.7	9.2	60.3	7.8	8.7	10.0	47.9	24.6
T75P25	15.5	9.1	61.4	5.9	7.5	9.6	48.4	27.0
T50P50	17.0	9.4	56.7	6.7	8.4	9.8	47.8	25.6
T25P75	19.4	10.0	52.1	8.1	10.5	10.2	45.6	22.8
P100	21.6	9.7	43.8	5.1	17.0	11.3	35.3	10.6
LSD (P=0.05)	2.40	0.59	2.16	2.22				
P100	19.1	8.3	50.3	2.9				
W100	15.5	8.7	64.6	3.7	11.2	9.4	51.8	16.8
W75P25	17.7	8.7	58.7	4.2	10.7	9.5	51.5	18.6
W50P50	16.8	8.4	58.8	2.4	12.4	9.7	49.4	14.8
W25P75	18.3	8.8	55.6	3.1	10.9	9.3	51.5	14.3
LSD (P=0.05)	1.91	0.40	2.91	1.23	1.34	0.43	2.28	1.70

Table 3. Dry matter content (DM)(% DM), crude protein (CP)(% DM), metabolisable energy (ME)(MJ/kg DM) and neutral detergent fibre (NDF) (%DM) of silages made from triticale (T), wheat (W), peas (P) and cereal/pea combinations made with either Sil-All 4x4, LaSil additives or untreated

	DM	CP	ME	NDF
T100	29.8	8.1	9.0	59.9

T75P25	29.0	8.8	9.1	59.1
T50P50	30.3	8.8	9.3	58.5
T25P75	26.1	11.5	9.5	54.9
P100	19.1	15.9	11.5	37.1
W100	30.6	11.2	9.6	55.5
W75P25	26.6	11.9	9.8	54.1
W50P50	26.2	12.3	9.9	53.7
W25P75	26.1	13.5	9.8	54.9
LSD (P=0.05)	0.68	0.26	0.15	1.23
Control	27.1	11.3	9.7	54.0
Sil-All 4x4	27.3	11.6	9.8	53.2
LaSil	27.0	11.1	9.7	54.1
LSD (P=0.05)	0.39	0.15	0.09	0.71

Discussion

Although the inclusion of peas with wheat did not reduce DM yield, it did not improve the nutritive value of the standing crop at harvest. In contrast, triticale as a monoculture or at the higher triticale ratios out yielded peas although CP content did improve when peas were combined at the highest ratio (T25P75) with triticale. The DM yield for the pea treatment is not dissimilar to that observed by Kaiser *et al.* (2007), albeit with a different pea cultivar. This DM yield indicates that there may be potential in growing peas as a monoculture in this environment over the winter/spring period. Whilst sowing peas with triticale did not improve the nutritive value, there may in fact be merit in developing systems where the two forages are grown as monocultures but subsequently mixed prior to ensiling, thus ensuring the DM yield benefits of triticale and the nutritive value of peas are combined. Based on the data from this study and a 50:50 mix of pea and triticale monocultures, DM yields, ME and CP values of close to 14 t DM/ha, 10.5 MJ/kg DM and 12.2% at ensiling may be achievable suggesting this may be a viable option. Based on ME content such resultant silage would in turn be considered suitable for inclusion in the diets of lactating dairy cows (Chamberlain and Wilkinson 1996).

The resultant silages further highlight the high nutritive value of peas in contrast to the forage cereals. Where peas were included at rates above 50% of the mix, the CP and ME were generally higher than for the cereal monocultures. Furthermore, if total ME per ha (GJ/ha) is calculated, the P100 (138,449 GJ/ha) out yields all treatments except T50P50 and T75P25 and the P100 also produces the most CP per ha. The DM content of peas at ensiling was markedly lower than all other treatments and at the levels observed it would generally be considered appropriate to wilt prior to ensiling. At this DM content, the WSC as a proportion of fresh weight was 2%, below the level considered required for adequate fermentation to occur (McDonald *et al.* 1991). Whilst this may indicate difficulties with ensiling, the fact that the CP content of the pea silage has remained constant in relation to the fresh material indicates a more controlled fermentation with little loss through extensive proteolysis. One of the benefits of direct ensiling is a reduction in the likelihood of field losses, therefore it may be possible to either defer ensiling until the DM of the standing crop increases or ensile with a higher DM material such as a forage cereal. The use of Sil-All 4x4 silage additive appears to have led to improvements in the CP content of silage, indicating that it may have limited protein breakdown during fermentation, a feature of this additive. Analysis of fermentation parameters (pH, ammonia-N, lactic, acetic and butyric acid) will provide further information on the effects of silage additives.

Conclusion

Winter cereal crops can be used in dairy systems to provide high DM yields of forage for ensiling, but improvements in the nutritive value are required. The inclusion of peas with cereals did not adversely affect DM yields of wheat but only led to small improvements in nutritive value. The results indicate that there may be potential to grow forage cereals and peas as monocultures and develop strategies to subsequently mix and ensile together.

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