Glycinebetaine foliar application increases pasture winter growth and milk yield

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Abstract

Foliar application of glycinebetaine @1 kg/ha increased winter pasture growth compared to a normal practice of N application @50 kg/ha. For every $1 spent on glycinebetaine or N, increase in pasture dry matter was 29 and 10 kg, respectively. Glycinebetaine also increased protein content of pasture, and milk yield in spring-calving cows. However, it lowered butterfat content.

Introduction

Winter pasture growth is severely limited in about 15 million ha of improved pastures in temperate Australia. Although farmers use N fertilizers to minimise this problem, sustainable winter pasture growth could be obtained through natural cold tolerance mechanisms of plants. Cold tolerant plants accumulate a group of natural compounds called “osmoprotectants” such as Glycinebetaine (betaine) as an adaptive mechanism (1). Betaine has been used as an index of stress tolerance in plant breeding and in genetic engineering (2). This paper examined the external application of glycinebetaine, in comparison with N fertilizer on pasture growth in winter and its effects on milk yield and butter fat content in the cows grazing on betaine-treated pasture.

Methodology

Field experiments were conducted in winter (June- September 1993) at Caveside, and Elliott Dairy Research Stations (EDRS) in Tasmania. Experimental design was a split-plot in completely randomised blocks. The main factor, betaine was foliar applied at: 0,1, 2, and 4 kg/ha mixed in 200L/ha of water and a non-ionic wetter, Plus-50 @ 2ml/L. N in the form of urea was drilled as sub or split plots using a tractor at 0, and 50kg N/ha. Betaine is produced as a by-product of sugar beet industry in Europe. Each treatment was replicated 3 times, with a plot size of 40m long and 10m wide. Pasture dry matter was measured 90 days after the treatments by mowing a strip of 0.5 x 20m in each plot. Oven dry samples were ground in a cyclonic mill to less than 1mm sized particles to estimate *in vitro* digestibility, and crude protein (%) by using Near Infrared Reflectance (NIR) spectroscopy method (B.P.Naidu, unpublished). In a third field trial in August 1993, 48 cows were divided at random into two equal groups called Control and Betaine cows. Each of these two groups consisted of two sub-groups of spring or autumn calving cows. At EDRS, 25 paddocks were selected and each paddock was fenced into two equal halves. One half of each block was foliar treated with betaine @ 1kg /ha (water and wetter as stated above) 3 weeks before grazing, while the other half was control. Grazing continued for 25 days. Milk production was measured daily in the morning and afternoon. Cow weights, butterfat, protein, and solids not fat were measured at the beginning of the field trial and at weekly intervals there after.

Results

At Caveside, betaine application of 1 kg/ha significantly increased pasture growth compared to no betaine or N application (Table 1). Nitrogen application @ 50 kg N/ha increased winter pasture growth from 1.42 to 2.05 T/ha (Table 1). Interaction between N and betaine application was not significant. A similar response was recorded at EDRS. Pasture quality was measured on the samples collected at EDRS only (Table 1). Neither betaine nor N altered the digestibility of pasture. The application of betaine @ 1kg/ha, or N @ 50kg/ha increased crude protein content from a control value of 19.9 to 20.8%.

Milk samples collected from the control or betaine cows showed no trace of betaine when measured by a HPLC method (3). Grazing on betaine-applied pasture resulted in an average increase in milk yield of 2.4 L/cow/day in spring calvers (Table 2), whereas in autumn calving cows, average milk yield was reduced by 1.2 L/cow/day. Grazing of betaine-applied pasture significantly reduced butter fat content. (Table 2). There was no effect due to calving or the interaction of calving and betaine application on butter fat content. Consumption of betaine-applied pasture did not result in any changes in milk protein and solids not fat (data not included). Betaine cows gained 13.1kg/cow body weight (the difference between the initial and weekly measures of weights) compared to 6.4 kg/cow in controls in 25 days. Cows allowed to graze *adlib* on betaine-treated or control pasture showed no difference in feed intake (data not included).

Table 1: Pasture growth and quality in response to betaine and N application

Treatment (kg/ha)	Pasture growth (T/ha)		At EDRS	
	At Caveside	At EDRS	Digestibility (%)	Crude protein (%)
Betaine-0	1.44	3.30	76.8	19.9
Betaine-1	1.89	3.82	77.5	20.8
Betaine-2	1.91	3.65	76.6	20.3
Betaine-4	1.71	3.39	76.4	20.3
LSD (p<0.05)	**0.24**	**0.37**	**NS**	**0.4**
N-0	1.42	3.32	76.0	19.8
N-50	2.05	3.75	77.6	20.8
LSD (p<0.05)	**0.21**	**0.29**	**NS**	**0.8**

NS, Non-significant

Table 2: Milk yield and butter content from cows fed on pasture with or without betaine application

	Milk yield (L/cow)				Butter fat (%)	
	Morning		Afternoon		Morning	(a) Afternoon
	Spring	Autumn	Spring	Autumn		
Betaine	12.8c	11.3a	8.1b	7.2a	3.4c	4.2b

Control	11.3a	12.2b	7.2a	7.5a	3.7b	5.0a

Values followed by the same letter are not significantly different by "analysis" (P<0.05)

Discussion

This study shows for the first time that winter pasture growth can be increased economically by the foliar application of betaine. It appears that the foliar applied betaine may have benefited the plants by protecting organelles or enzymes against low temperature (4). In addition, betaine may have been translated to the root nodules and assisted cold stressed *Rhizobium* to fix N. The response from 1 kg of betaine is almost equal to the response obtained from 50 kg of N (Table 3). The application cost being equal for both the treatments, for every dollar spent on betaine, or N; farmers will get 29 and 10 kg pasture dry matter, respectively. The reduction in the butter fat content as a response of betaine treatment is in line with betaine reducing fat content in animals (5). However, it is not clear whether betaine altered the butter fat saturation level. If it did, then this will have potential for producing margarine like butter. This work suggests that betaine could be used agronomically or in breeding to produce cultivars tolerant of cold weather.

Table 3: Increase in pasture dry matter production (kg/ha) in response to betaine, or N application (data is from betaine x N interaction, which is not shown)

	Caveside	EDRS	Average	Dry matter increase (kg)/ $1 spent
1 Kg Betaine	512	645	579	29
50 Kg N	540	454	497	10
Betaine + N	1034	957	993	14

Unit price of betaine, and N is $A 20 and $A 1, respectively.

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